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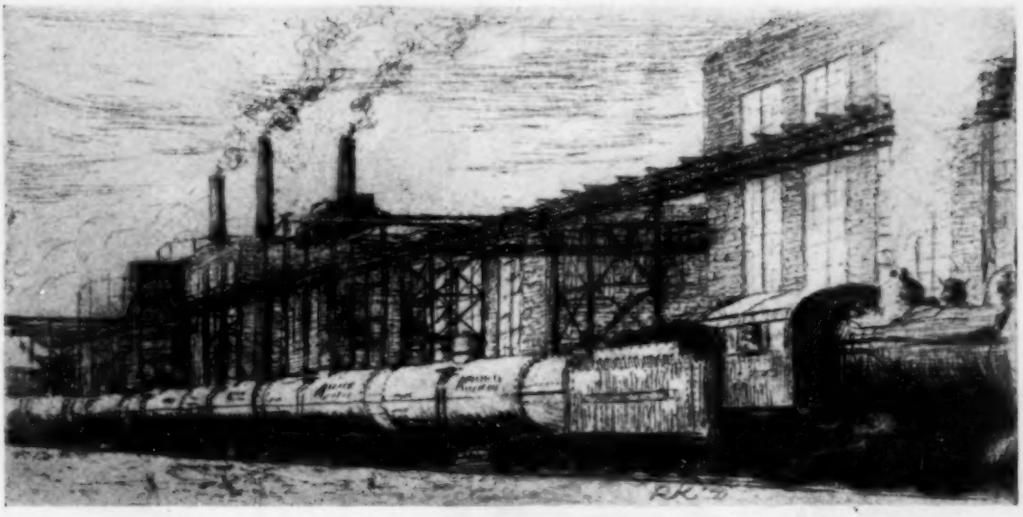

Transporting Anhydrous Ammonia From the Atmospheric Nitrogen Corporation at Hopewell, Va.

April, 1930—Materials Handling

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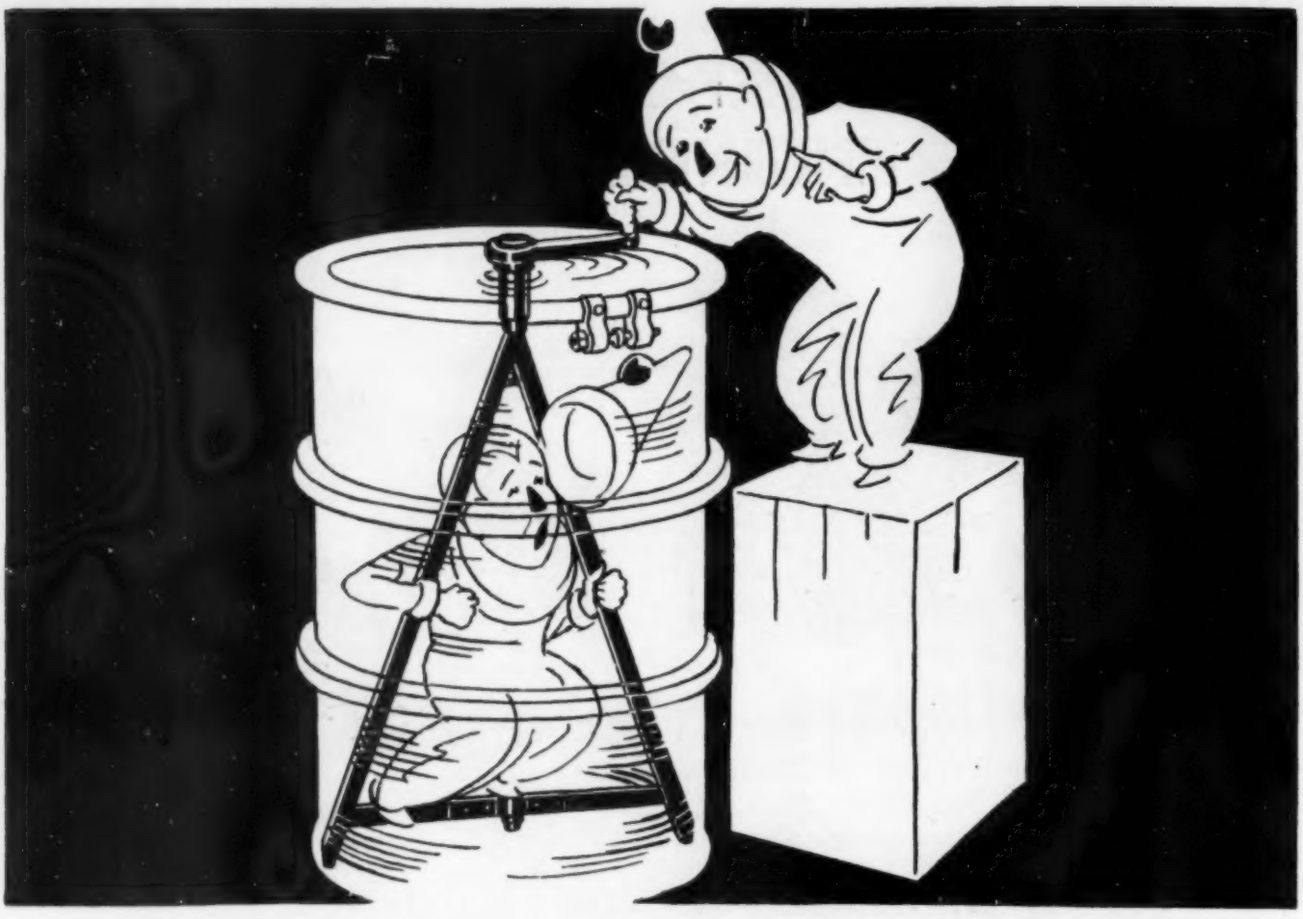

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S. D. KIRKPATRICK, *Editor*

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What Mechanical Handling Offers

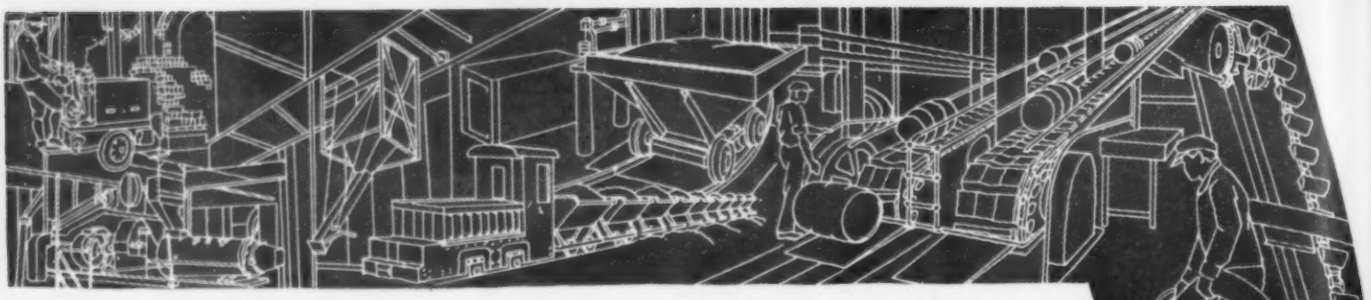
To the Chemical Engineer

CHEMICAL ENGINEERING owes much to the older arts and sciences from which it sprang. To the mechanical engineer, for example, it is indebted for the origin of many of the highly developed unit operations which are now recognized parts of the chemical engineer's stock in trade. Other important fields of activity, such as the mechanical handling of materials, however, have largely remained the function of the mechanical engineer, whose ingenuity has developed the equipment and perfected its application until it has become a major factor in all of our industrial progress.

WITHOUT any desire to appropriate the function for his own, the chemical engineer will nevertheless profit greatly by a study of what mechanical handling can accomplish in the process industries. Great as are its contributions in lowering costs and increasing productivity, it has a more significant influence in the control of production. Materials handling equipment often becomes a pace setter for the entire manufacturing process. It may eliminate a "bottle neck" in the orderly flow of materials through the plant. Mechanical handling may also be a great co-ordinator of chemical engineering operations. Batch processes are sometimes made continuous merely by its introduction. The separate unit operations become a manufacturing process when mechanically co-ordinated. Lastly, materials handling machinery is a stimulant to greater output for the individual and for the plant. Men released from drudgery and fatigue are available for more important work in expanding production and building for the future.

THIS ISSUE of *Chem. & Met.* brings to its readers a veritable handbook of materials handling. The mechanical engineering concept has been interpreted from the viewpoint of the chemical engineer to give him a clearer picture of the types of equipment available, the field of their application, and the records of their performance. In the articles that follow there are specific examples of how these principles are being applied in the various chemical engineering industries. Discussion of the closely allied fields of interplant handling—packaging and shipping of the finished product—serves to supplement and round out this unique symposium.

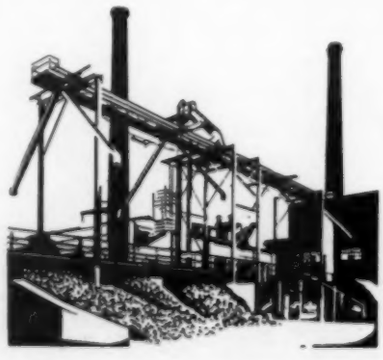
PRESIDENT HOOVER'S Committee on Recent Economic Changes characterized the aid of modern materials handling machinery as "probably the greatest single improvement which has come in the technical operation of manufacturing establishments since 1919." Certainly it is a challenge to the chemical engineer to utilize to the maximum this great mechanical tool for increased efficiency in both production and distribution.



"Handle Mechanically . . ."

PERHAPS the chief attribute that distinguishes modern man from his early ancestor is his use of mechanical methods for getting things done. Materials handling, as the process of transporting objects from place to place, is the outcome of evolution as old as humanity. Yet in its mechanical phases, it has only come into being since the start of the last century. At the dawn of history man's only means of transportation lay in himself. His problems were simple and this proved no disadvantage. Defense, we may well believe, occupied a predominant place in his thoughts. How to move heavy stones from the entrances of strategically located caves was a vital matter to him, and his discovery of the first vague beginnings of mechanics, embodied in his use of the lever and the inclined plane, was the most important event in many centuries. Much later he mingled a little constructive thought with his sweat and evolved the beast-of-burden idea. But manpower was still the most easily harnessed force in the universe; and it was also very much the cheapest.

NOW skip a thousand centuries to the age of the pyramids. Those huge piles of limestone are monuments to the almost unbelievable ingenuity of primitive engineers, but they are also monuments to man's prodigious capacity for brute effort. Contrast the sheer drudgery of their erection with the effortless manner in which today's pinnacles of industrial achievement arise on every side. Compare the products of manpower with those of "horsepower." Today, Mahomet beckons and the mountain comes to him in mile-long railway trains. Explosives and power shovels have torn his mountain to bits while draglines and belts have loaded his cars. Thousands of horsepower have hauled his trains wherever he willed.



IT IS no longer true that manpower is cheapest. Generally speaking, the most expensive unit of industrial equipment today is the man with the shovel and wheelbarrow. In the United States, at least, he is a luxury that most of industry can ill afford. Entirely aside from the fact that the common laborer is a commodity which is fast disappearing under the influence of the immigration quotas, "bull work" is too costly in any case where there is sufficient volume of handling to permit the reasonably complete utilization of mechanical equipment. This does not mean that a thousand-dollar system is necessarily justifiable for a ton-a-week load. It does mean that industry, and particularly chemical engineering industry, cannot afford to take materials handling for granted. No division of the production set-up is more deserving of competent engineering analysis.

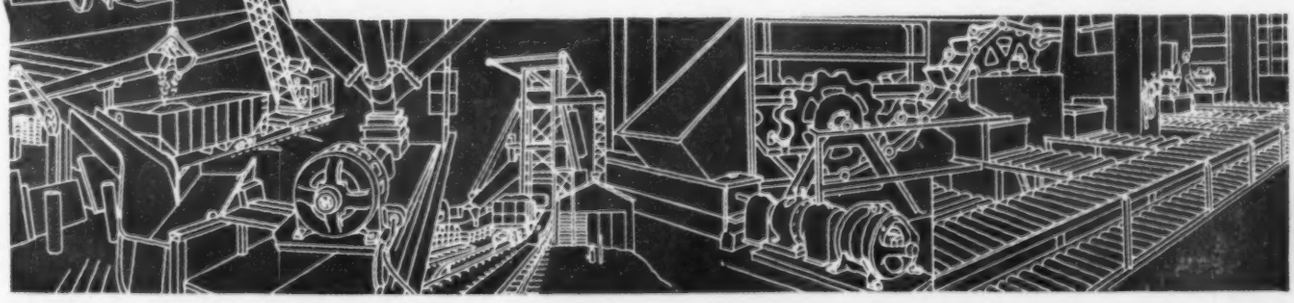
Just how important is materials handling? Reliable estimates prepared by the Committee on Recent Economic Changes show that handling within the plant accounts for fully 22 per cent of industry's labor payroll, and that this is equal to 80 per cent of the amount going into product transportation outside the plant. Surely such a figure is worth al-

most any effort needed for its reduction.

And there is no question but that reductions can be made. Direct savings are only part of the advantages to be gained from more efficient handling. Pacing of production, reduction in inventories, improvement in quality and increase in output per unit of floor space are almost certain to follow. It is true that this may be accompanied by technologic unemployment, so-called, but it has not been proven that this is permanently harmful either to industry or to the worker. Rather, it appears to redound to the ultimate advantage of both, releasing as it does much "bull labor" for more productive effort. High wages, high productivity and low costs have created a prosperity in this country which is relatively unaffected by the valleys of the business cycle. Not a little of this prosperity can be credited directly to efficient mechanical handling. A country in which 20 million automobiles and ten million radios have deserted the ranks of luxuries can thank mechanical handling in large part, particularly in the automobile industry, for bringing about this condition.

WHAT then of materials handling in chemical engineering plants? No one can deny that many opportunities have already been followed to their logical conclusion. A leather plant saved 40 per cent in its tannery and beam house through complete conveyorization. A dry-battery plant doubled production without increasing floor space. A paper company reduced handling costs by 20 thousand dollars per year. Many more cases might be cited where at least equal improvement has been effected. Numbers of plants, for example, have turned to bulk handling, materially reducing packing, handling and shipping costs. Others have bent their attention to the elimination of rehandling, particularly through the use of skids for storage and shipment. U. S. Department of Commerce is authority for the statement that certain paper companies have cut handling and packing costs well over 25 per cent by this means.

STILL, the time is ripe for a more complete understanding of the fundamentals underlying mechanized materials handling. Competition is forcing every chemical engineering producer to a more careful analysis of his manufacturing facilities. It is forcing every designer of chemical engineering plants to look to the edge on his tools. Mechanical handling is—and rightfully—part of the stock in trade of the mechanical engineer. It is out of the question to expect the chemical engineer to become a past master in its application. But a grasp of its fundamentals is highly to be desired. It is a tool which, when properly applied, will never turn in the user's hands; which, properly maintained, will never lose its capacity for chiseling the rough corners from the process structure and routing out a handsome return on the investment. It is for these reasons that this issue of *Chem. & Met.* is given over to mechanical materials handling. Study of its pages will disclose a dual type of treatment. First we examine the subject under the microscope of general analysis. Following this we turn to the telescope of specific illustration. The result, utilized in connection with the yardstick of practicability, should enable the chemical engineer to "Handle Mechanically . . . " wherever economy may dictate.



Intraplant MOVEMENT In Chemical Engineering Industries

MATERIALS HANDLING, the transportation of solids, semi-solids and containers, is one of the most important tools of the chemical engineer. He need not know the intimate details of design of equipment for this purpose, but he must understand its scope and possibilities. Enormous savings are to be effected through improved handling in the plant. To assist chemical engineers in the selection of equipment for this desirable end, Mr. Montgomery has prepared the following condensed materials-handling handbook.

By G. L. MONTGOMERY

Mechanical Engineer
McGraw-Hill Publishing Company
New York

SOLID MATERIALS moved in the chemical engineering industries include raw materials, materials-in-process, and finished products. Among solid raw materials are quarry products such as limestone, phosphate, dolomite, shale, clay, gypsum, bauxite, and sand; mined products such as salt, sulphur, coal, pyrites, metallic ores, and minerals such as feldspar and natural pigments; asphalts, waxes, pitches, vegetable products such as wood, cotton, cottonseed, flaxseed, palm kernels, soya beans, copra, raw sugar, sugar beets; cellulose-bearing materials such as bagasse, straw, and pulp; crude rubber; and animal products such as hides, fats and bone.

Solid materials entering a process often become fluid, while materials entering a process as fluids often become solid. Solid materials-in-process are powdered, granular, or bulky in form, and their nature will depend upon the processing which they have undergone. This must be determined by a study of the particular industry to which the materials handling equipment is to be applied.

Solid finished products of the chemical engineering industries include such materials as coke, charcoal, sugar, salt, soap, pottery, porcelain, brick, explosives, fertilizer, glass, gelatin, caustic, leather, lime, cement, grease, pigments, paper, pulp, rubber products and dyes.

This article, with certain additions, is to appear as part of a section on movement and storage of solids, liquids and gases, in the forthcoming "Chemical Engineer's Handbook" now in preparation for the McGraw-Hill Book Company, under the editorship of John H. Perry and William S. Calcott of E. I. duPont de Nemours & Company.

Containers are used for holding solid, liquid, and gaseous materials, whether these are raw materials, materials-in-process, or finished products. Common types of containers, all of which must be handled as if they were solids, include bales, bags, boxes, kegs, barrels, drums, bottles, carboys, tanks, packages, saggers, and special skid platforms.

Four general classes of equipment are available for handling solid materials and materials in containers. These are:

1. Conveyors
2. Overhead Equipment
3. Trucks and Tractors
4. Industrial Railways

Conveyors

Conveyors usually are permanent structures and frequently are integral parts of the manufacturing equipment. Portable conveyors of various types also are available for certain classes of work.

Types of conveyors, classified in accordance with the direction of movement for which these are primarily suited, are:

Horizontal Movement

Belt conveyors.
Chain or cable conveyors.
Chain trolley conveyors.
Platform, apron, slat, and pan conveyors.
Gravity roller conveyors.
Live or driven roller conveyors.
Bucket carriers.
Scraper, flight, pusher-bar, and drag conveyors.
Screw conveyors.
Dragline scraper conveyors.
Pneumatic conveyors.
Solids pumps.

Vertical Movement

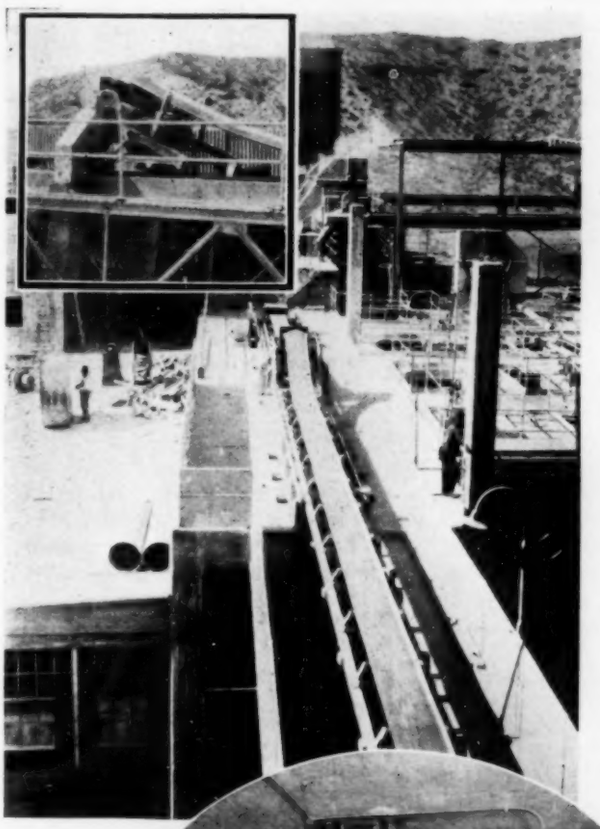
Bucket elevators.
Skip hoists.
Chain elevators.
Barrel, package, bag and tray elevators.
Bucket carriers.
Belt elevators.
Spiral chutes.
Roller spirals.
Chutes or spouts.
Pneumatic conveyors.
Solids pumps.

Combined Vertical and Horizontal Movement

Inclined belt conveyors.
Inclined chain conveyors.
Inclined chain trolley conveyors.
Inclined scraper, flight, drag and pusher-bar conveyors.
Inclined platform, apron, slat and pan conveyors.
Inclined live roller conveyors.
Inclined gravity roller conveyors.
Inclined screw conveyors.
Bucket carriers.
Chutes.
Pneumatic conveyors.
Solids pumps.

THE AUTHOR writes from a background of intimate association with chemical engineering industries. After graduating in mechanical engineering from Columbia in 1912, ten years of varied industrial experience included the design, construction and operation of byproduct coke, tar distillation and toluol recovery plants. For a time he was engineer in charge of specification and design of conveying and other mechanical handling equipment for Lockwood, Greene & Company. Since 1922 he has been with the McGraw-Hill Publishing Company, for five years as assistant editor of *Chem. & Met.* and more recently as associate editor of *Power*.

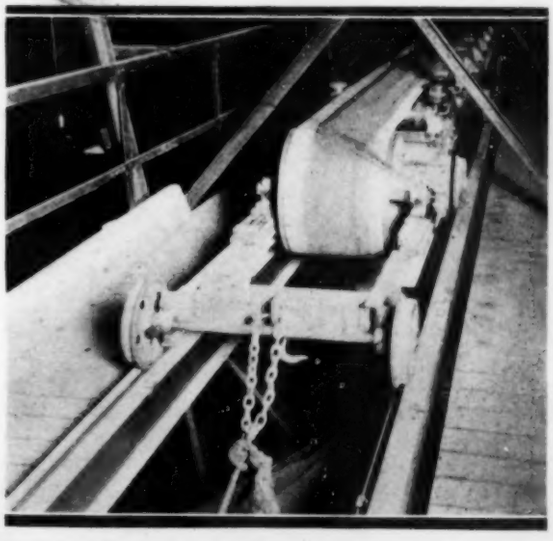
# of MATERIALS

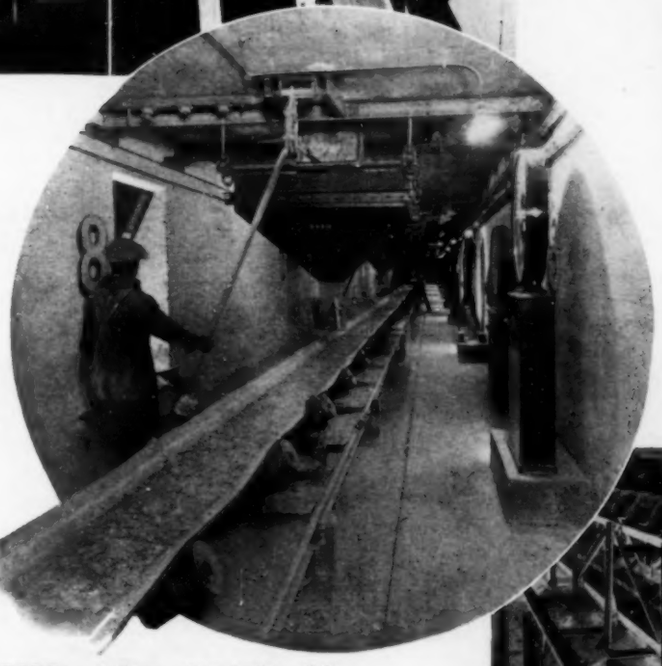


¶ LEFT: This Stephens-Adamson 30-in. belt conveyor, installed in the 6,000-barrel-per-day plant of the Southwestern Portland Cement Company at Victorville, Calif., carries crushed rock from storage to the wet grinding mills. Note the movable tripper which discharges at any desired point. The insert shows a side view of a similar tripper on the rock storage conveyor at this plant.

¶ ABOVE: Link-Belt apron conveyor for hot cullet installed in the plant of the American Window Glass Company at Arnold, Pa. Note the all-metal construction and chains and rollers.

BELOW: This portable, or "shuttle" belt conveyor, made by Stephens-Adamson, is used to store the raw materials for light-weight cement tile in the plant of Federal Cement Tile Company at Hammond, Ind. It is moved to discharge at any desired point in the storage building.





¶ ABOVE: Jeffrey glass-batch belt conveyor running beneath the raw material silos of the Libby Owens Sheet Glass Company at Kanawha City, W. Va. All components of the batch are weighed into the various hoppers, then dropped to belt and conveyed to mixers.

RIGHT: Jeffrey scraper conveyor installed in the leather plant of Graton & Knight Company at Worcester, Mass. It is used in transporting lime, unloaded from cars by means of electric power shovels, to lime storage.

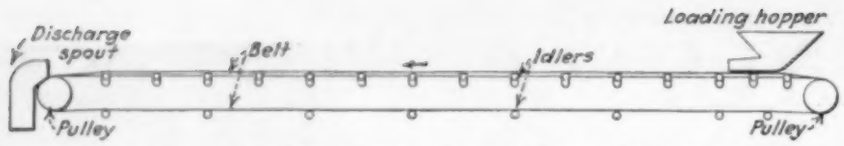


Fig. 1—Simple Type of Horizontal Belt Conveyor Loaded at One End by Hopper and Discharging Into Spout; Belt May Be Troughed or Flat

These types of equipment are defined as follows:

Belt conveyors—Fig. 1—consist of endless belts carried on a driving pulley at one end of their run and an idler pulley at the other end, and supported at appropriate intervals in both the top and bottom parts of the run by rollers. Material is carried on the upper surface of the belt in either or both parts of the run but usually on the upper part. Driving equipment, take-ups to keep the belt at the proper tension, and loading and unloading devices such as belt-trippers and feeders are the important accessory devices.

Chain conveyors consist of endless runs of chain or cable carried on a driving sprocket, idler sprockets, and

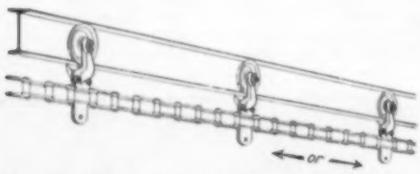


Fig. 2—Chain Links, Roller and Guide as Used in Simple Form of Chain Conveyor of Trolley Type for Overhead Service

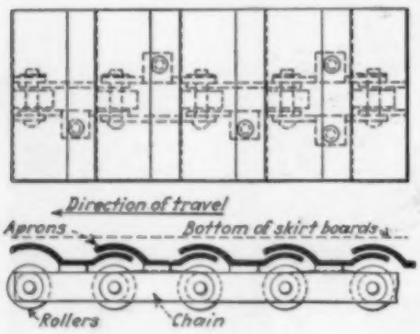
by means of rollers, on guides and equipped with hooks, pushers, or other devices for engaging the material to be moved. Loading and unloading devices are not standard, but, if used, are designed for the material to be handled. Take-ups and driving equipment are the chief accessories.

Chain trolley conveyors—Fig. 2—are a variant of the chain conveyor, adopted for overhead service by the use of trolleys which serve to support the conveyor and allow it to move along a suspended track of I-beam or inverted T-beam type. Loads are suspended from the chain, generally at points directly beneath the trolley attachments, by means of hooks or carriers. In general practice with these conveyors, the trolley serves to transmit the load to the track, while the chain serves as a means of moving the conveyor.

Platform, slat, apron and pan conveyors—Fig. 3—consist of one or two parallel, endless runs of chain or cable, or of a belt, upon the outer surface of which are affixed platforms, aprons, slats, pans or other receptacles. These conveyors are provided with driving and idler sprockets or pulleys at the ends of the run and suitable guides or supports for the top and bottom parts of the run. Driving equipment and take-ups are the chief accessories. Loading and unloading

Fig. 3—Sketch of Part of Simple Type of Apron Conveyor

Two chains are used in larger sizes, placed at sides of aprons. Pans, slats, or platforms may replace the aprons to suit the purpose of the conveyor



devices, when used, are designed to suit the needs of each application.

Gravity roller conveyors—Fig. 4—consist of a succession of rollers mounted on ball or roller bearing spindles and held between the parallel sides of a structural steel frame. Live roller conveyors, or chain conveyors such as the pusher-bar type, frequently are used in connection with gravity roller conveyor to accomplish vertical lifts of the material.

Live or driven roller conveyors are similar to gravity roller conveyors, with the addition of a means, such as bevel gearing, for positively rotating the rolls. Accessories consist of the driving equipment.

Bucket carriers—Fig. 5—whether of the V-bucket, gravity discharge, or of the pivoted bucket type, consist of one or two endless chains employed as in chain conveyors, but carrying a series of attached buckets which serve as receptacles for the material being handled. Buckets discharge by gravity or, in the case of the pivoted type, by means of a tripping arrangement. Accessories are the same as used with chain conveyors. Loading is usually by hopper and spout.

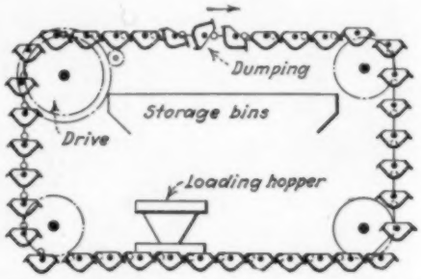


Fig. 5—Sketch of Simple Pivoted Bucket Carrier Layout

Scraper, flight, drag, and pusher-bar conveyors—Fig. 6—consist of one or more chains, in general similar to those making up chain conveyors, but passing through a trough or set of guides, so that the motion of the

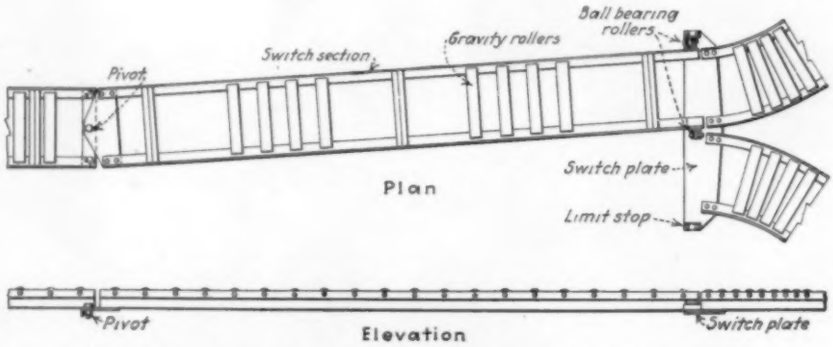
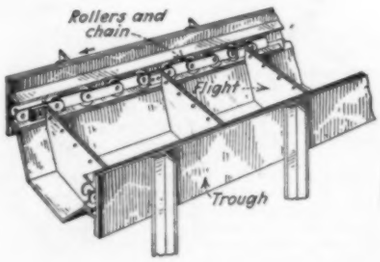


Fig. 4—Gravity Roller Conveyor, Showing Switch Section, Indicating Flexibility of Such Equipment

chain, either alone or assisted by attachments such as flights, moves the material that is placed in the trough or between the guides. Accessories are generally the same as for chain conveyors. Loading and unloading

Fig. 6—Scraper Flight Conveyor, Which Illustrates Method of Using Guided Chains With Attachments for Conveying



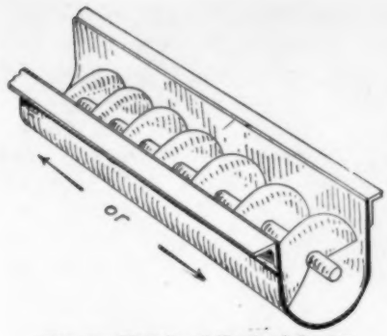


Fig. 7—Sketch of Part of Screw Conveyor in Open Trough

devices are designed to suit the application.

Screw conveyors—Fig. 7—consist of shafts having a continuous helical fin or projection, and rotating in a trough or casing in such a way that the fin pushes the material handled from one end to the other. Accessories consists of driving equipment, bearings, and unloading and loading devices designed to suit the particular installation.

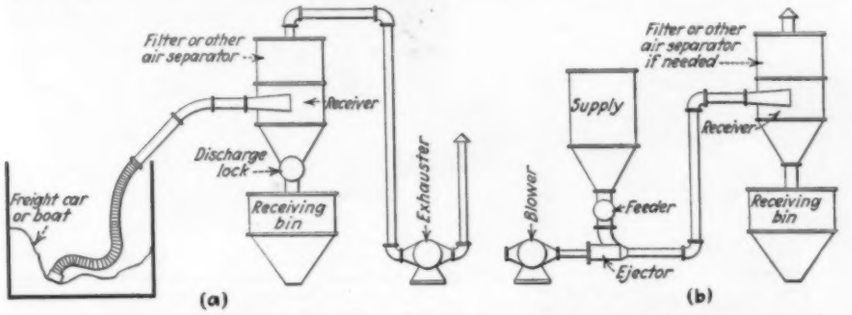


Fig. 8—Schematic Diagrams of Two Most Common Types of Pneumatic Conveying System
(a) Suction type for unloading or taking a supply from several points to one discharge point. (b) Pressure type used principally in taking supply from one point to several discharge points

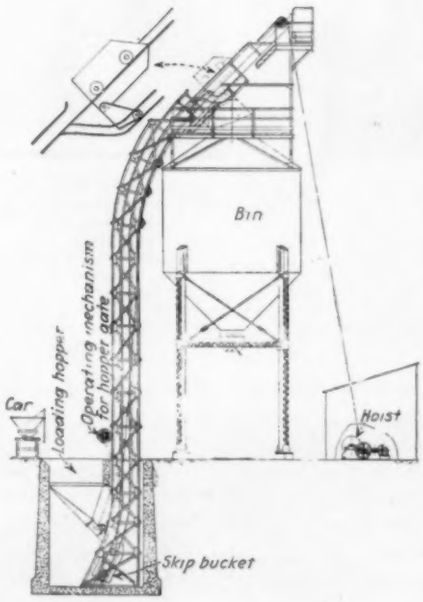
Fig. 9—Typical Bucket Elevator With Spaced Buckets and Centrifugal Discharge
Other types have continuous buckets or positive discharge

Pneumatic conveyors—Fig. 8—consist of equipment for either sucking or blowing through a pipe line any material that can be handled in such a manner. Parts of this equipment generally comprise an intake or feeder, a pipe line and fittings, a separator, an air-locked discharge, and a blower or exhauster with its motor.

Bucket elevators—Fig. 9—consist of an endless belt, or one or more endless chains, passing over pulleys or sprockets at top and bottom, and with a succession of buckets attached for holding the material that is conveyed. There usually is a specially designed loading hopper, called a "boot"; a casing, and a discharge hopper or chute. Usual accessories are take-ups and driving mechanism.

Skip hoists—Fig. 10—are automatic elevators in which a single large bucket, or "skip," is raised by the winding of a cable on a drum, the bucket being guided in a structural steel frame and automatically dumped at the top of the run. The hoist is designed for quick return. Usual accessories are the hoist drive, a feeder for loading and some type of chute or hopper for discharge.

Fig. 10—Skip Hoist, Used for Elevating Materials to Storage Bins



Chain elevators, barrel, package, and tray elevators, are all variations of the same mechanism, which consists of one or more endless chains running over sprockets at top and bottom, with or without a casing, as desired, and equipped with some type of engaging device for supporting barrels, packages, trays, or other material. Usual accessories are driving mechanism and take-ups. Loading and unloading devices generally are special.

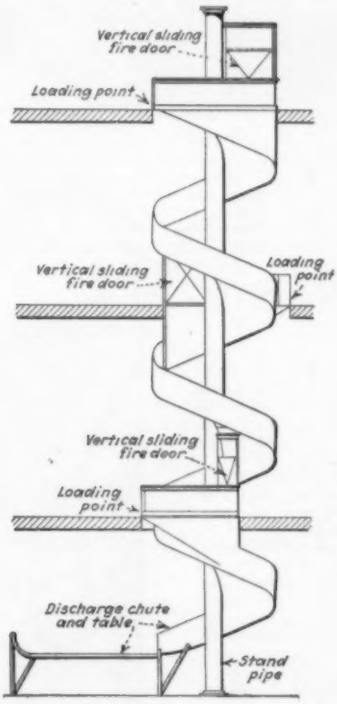
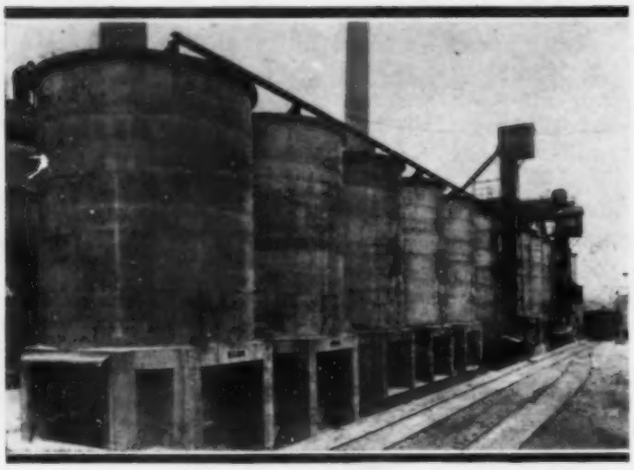


Fig. 11—Open-Type, Single-Blade Spiral Chute; Double-Blade and Inclosed Types are Available

Belt elevators consist of an endless belt, running over pulleys at top and bottom, and having affixed to the outer surface, cleats or some other means of moving material. These elevators may have a casing if desired. Important accessories are take-ups and driving equipment. Special means for loading and unloading may be provided.

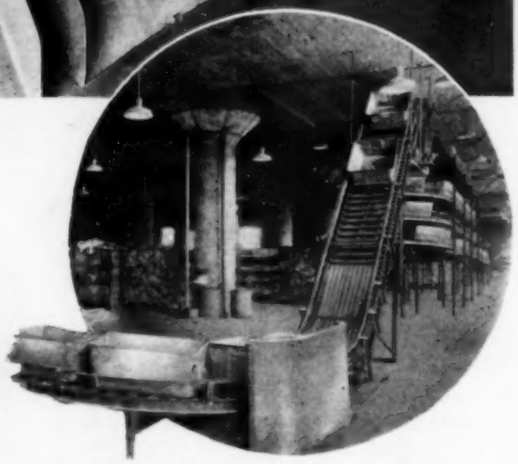
Spiral chutes—Fig. 11—consist of a helically formed sheet of metal attached to a center post or core and enclosed in a casing—or not—as desired. The material slides downward upon the upper surface of this plate, which is smooth to permit easy passage. Special loading or unloading devices are sometimes used with chutes.

Roller spirals are similar in purpose to spiral chutes and differ only in having a spiral formed of gravity

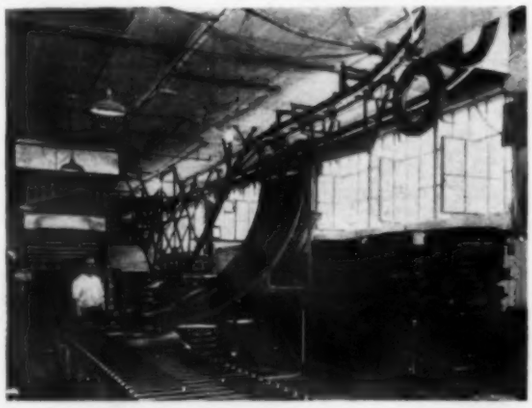


LEFT: Raw material storage bins in the plant of Owens-Illinois Glass Company at Kanawha City, W. Va., are loaded by means of Link-Belt and Webster portable bucket elevators, fed by power-shovel unloaders.

RIGHT, above: A Chain Belt Company screw conveyor transports material from the cookers in the plant of the Retail Tallow & Calfskin Association. Note the removable cover plates in the floor.



RUBBER factory conveying is highly developed. Pusher bar roller conveyors, of Standard manufacture, handle batch containers on incline and level in a large Mid-Western rubber factory.



RIGHT: View taken in the Fisk plant at Chicopee Falls, Mass., shows a Mathews installation for discharge of tires from a trolley conveyor 1,700 ft. long, to an inspection station and thence to shipping, via live rollers.

LEFT: Portable gravity roller conveyor, made by Lamson Company, discharges packing cases to a chute across a platform scale in the plant of Champion Spark Plug Company, at Toledo.

RIGHT: This view, taken on top of the finished cement storage silos at the Southwestern Portland Cement Company's plant at Victorville, Calif., shows Stephens-Adamson screw conveyors receiving cement from a belt and delivering to any of the several silos.

roller conveyor specially designed for the purpose. Their slope is less, so that they permit of moving loads vertically downward at a slower rate than on a spiral chute.

Chutes or spouts are metal strips formed in various ways so that material may slide within or on them from a higher level down to a lower level.

Dragline scraper conveyors—Fig. 12—are operated by a hoist and consist of a scraper or bucket attached between the ends of a cable that can be wound or unwound from the respective sides of a double drum. By means of appropriately placed guide sheaves, the scraper is caused to drag over and pick up the material to be moved. This conveyor can be used for storing material or reclaiming it from storage, depending upon the point of loading and unloading. It generally is used in conjunction with other conveyors.

Solids pumps—Fig. 13—may be considered as combinations of screw conveyors and pneumatic conveyors but are actually neither. Material of a finely divided nature, or made up of reasonably small pieces, is fed by

a screw through an air chamber where numerous jets of air are introduced from a ring around the pump casing. This aerates the material, expands it, and causes it to "flow," thus increasing the ability of the screw to force it through a pipe line to the point of delivery. Usual accessories are a drive for the screw, special valves for the line, and an air compressor.

Overhead Equipment

Overhead equipment is of two classes, that which lifts materials only, and that which also transports.

Lifting Equipment

Hand chain hoists.
Motor chain hoists.
Drum hoists and elevators.
Stationary cranes.

Lifting and Transferring Equipment

Hand-operated monorail or trolley systems.
Motor-operated monorail or trolley systems.
Hand-operated traveling cranes.
Motor-operated traveling cranes.
Locomotive cranes.

These types of equipment are defined as follows:

Chain hoists—Figs. 14 and 15—are lifting devices consisting of a chain which is wound on or unwound from a drum or sheave. The rotation of the drum is caused by a hand chain that passes over a sprocket; or by an electric motor, acting through a gear train upon the drum. The whole hoist is supported from above, either from a ceiling beam or from a structure built for the purpose. The hoisting chain is provided with a hook or other means of engaging the load.

Drum hoists and platform elevators operate on the same general principle as chain hoists, except that a wire rope or cable usually is substituted for the chain. The drum frequently is located at the lower floor level or ground level, with the hoisting cable passing through a sheave or guide pulley at the upper level. Steam engines, internal combustion engines, or electric motors are used for driving these hoists or elevators, generally through a gear train, although hand power sometimes is used. A cage, platform, hook or other means of lifting material is attached to the end of the cable. Usual accessories include a casing or guides for the load and controlling equipment for the drive. A brake is provided on the drum to enable the load to be stopped in the desired position. Counterweights are often used to compensate for the weight of the lift.

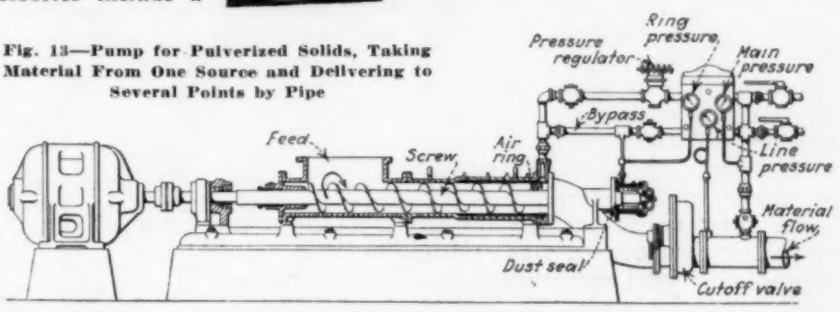


Fig. 13—Pump for Pulverized Solids, Taking Material From One Source and Delivering to Several Points by Pipe

Stationary cranes are used for lifting materials and moving them to points within reach of a boom constructed to rotate about a fixed column. They may be operated by hand or mechanical power. Loads are usually lifted by a hook or other device attached to a chain or cable that is wound up on a drum similar to that used with a hoist. This equipment is used largely for unloading cars and trucks and for handling heavy objects over a restricted area.

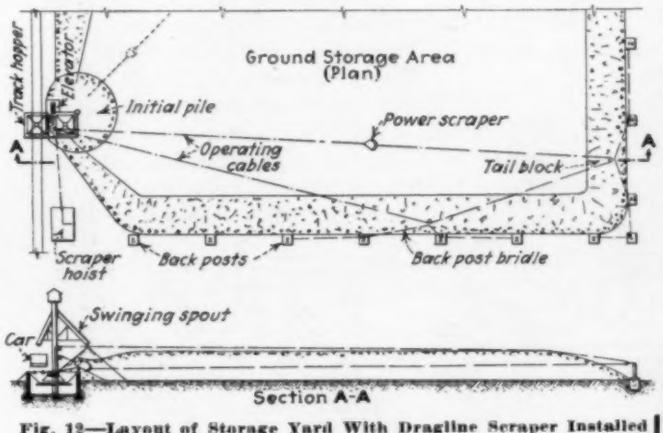


Fig. 12—Layout of Storage Yard With Dragline Scraper Installed

Monorail or trolley systems—Figs. 16, 17 and 18—are means of conveying materials along an overhead trackway consisting of a single rail or track of various suitable designs. The simplest form of such equipment consists of a light track suspended from a ceiling or suitable supporting structure, upon which operate various designs of wheeled carriers propelled by hand. One of the most used forms has for a carrier a hand or motor-operated chain hoist, propelled by hand. The more complicated forms of monorail systems have carriers consisting of motor-operated hoists that are propelled along the track by a motor drive. Such monorail systems are operated from the floor in the smaller sizes, while the larger types are provided with a cab in which the operator rides.

When a cable is substituted for the track upon which the carrier or hoist is supported, the device is called a cableway or telpher. These are used largely for the outdoor transport of heavy materials, as at mines or quarries.

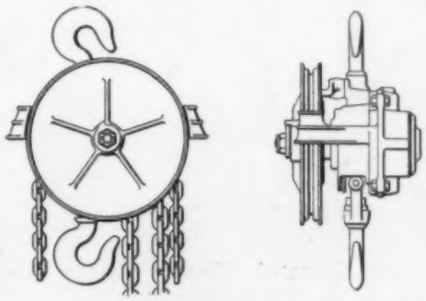


Fig. 14—Hand-Operated Chain Hoist

Traveling cranes—Fig. 19—are of two types. The ordinary traveling crane is a structural steel device consisting of two beams, rigidly connected at the ends and carrying be-

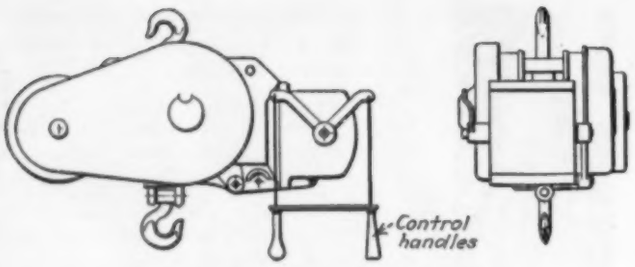


Fig. 15—Motor-Operated Chain Hoist

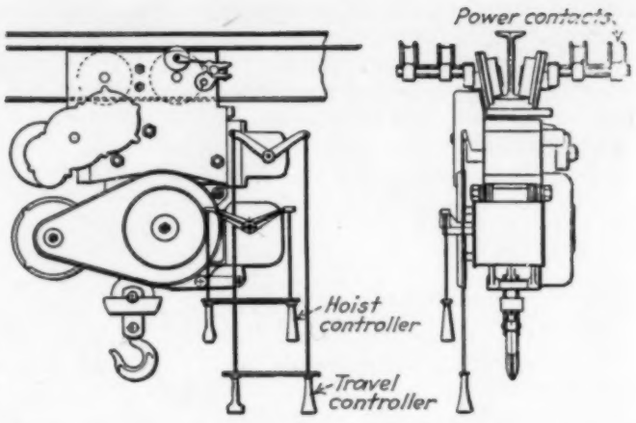


Fig. 17—Electrically Operated Monorail Trolley With Motor-Driven Chain Hoist, Arranged for Operation From Floor

tween the two beams a hoist. This hoist is arranged to move along the structure on tracks. The whole device is mounted at the ends on rails in such a manner that it can be moved at right angles to the direction of travel of the hoist. Such cranes are operated either by hand or motor drive, or are part hand and part motor driven. Gantry or bridge cranes are modifications of traveling cranes in which the whole crane is elevated above the tracks upon which it travels by means of structural supports. These latter cranes are adapted to service in outdoor storage yards where no overhead supporting structure is conveniently available.

Locomotive cranes—Fig. 20—are rail-cars with a crane of the stationary, revolving-boom type mounted upon them. The driving mechanism of the crane is arranged to propel the whole device along the track through a gear-train connection to the wheels of the car.

Trucks and Tractors

Trucks and tractors are of two general types, hand-operated and power-operated.

Hand-Operated

Lift trucks.
Platform trucks.
Container or box trucks.
Skid platforms used with lift trucks.

Power-Operated (Electric storage battery or gasoline)

Platform trucks.
Low-lift trucks.
High-lift trucks.
Crane trucks.
Special-purpose trucks.
Tractors.
Skid platforms for lift trucks.
Trailers for tractors.

These types of equipment may be defined as follows:

Hand-operated lift trucks—Fig. 21—are low platforms mounted on wheels and propelled by the operator, who pulls on a handle provided for that purpose. These trucks are provided with a hand-operated lifting mechanism, by means of which the platform can be elevated a few inches. The purpose of this is so that the truck can be pushed beneath a load standing on low legs and these legs then raised from the floor by raising the truck platform under the load. Thereupon the load rests on the truck platform and is moved by moving the truck. The forward wheels of the truck are mounted on a pivot to facilitate steering.

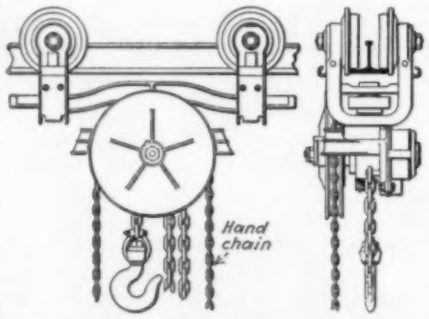


Fig. 16—Hand-Operated Monorail Trolley, or "Tramrail," With Hand-Operated Chain Hoist Attached
Other types of attachments, such as carriers, are used with monorails

Hand-operated platform trucks consist of platforms mounted upon wheels of suitable height and designed to carry a load directly upon this platform. The load is placed and removed by some outside means, as by hand or with a hoist.

Hand-operated container or box trucks are similar to the hand-operated platform trucks, with the addition of sides of suitable height which convert the platform into a box.

Skid platforms—Figs. 22, 23, 24, 25, and 26—for use with hand-operated lift trucks, consist of platforms mounted upon supports. These supports are of suitable height so that a lift-truck may be inserted between the platform and the floor, and, when the lift is operated, the platform is raised so that it may be carried along on the truck. Loads are placed upon the platform, which may be provided with sides as needed. If these platforms are supplied with wheels in place of skid supports, they may be moved by hand, and are more suitable to installations where flexibility of storage is needed. It is usual to store loads upon skid platforms in plants where the trucking system is employed, thus avoiding rehandling. In some cases, loads are shipped on skids by rail or boat, from one plant to another, to facilitate loading and unloading and reduce handling.

Power-operated trucks—Figs. 27, 28, and 29—are similar in purpose to hand-operated trucks, and are operated by electric motors supplied from storage batteries, or by gasoline motors. These trucks are available in a platform truck, a low-lift truck for handling skid platforms, a high-lift truck for raising loads to storage or working level, crane trucks,

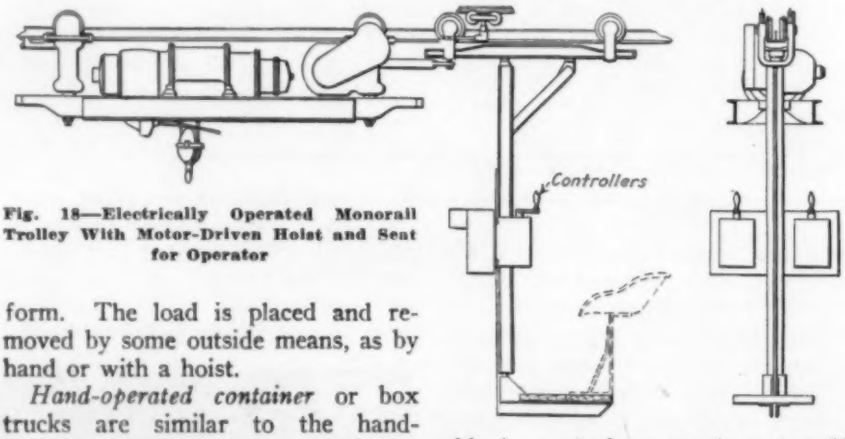


Fig. 18—Electrically Operated Monorail Trolley With Motor-Driven Hoist and Seat for Operator

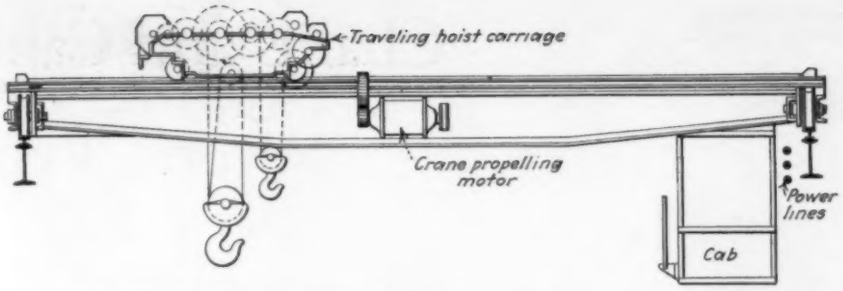


Fig. 19—Electrically Operated Traveling Crane With Cab for Operator

equipped with a crane for raising loads and somewhat similar in purpose to a locomotive crane, and many types of special-purpose trucks, designed to suit the needs of specific jobs, such as charging furnaces, lifting large newsprint rolls or casting metal.

Skid platforms for power-lift trucks are similar to those described for hand-lift trucks, except as to dimensions which are sometimes different.

Tractors—Fig. 30 — are storage-battery electric or gasoline-motor-driven trucks, designed for the purpose of pulling one or more loaded trailers — Fig. 31. These trailers are similar to hand-operated platform trucks, but are arranged to be connected in trains. Axles are attached to the body in a manner permitting the trailers to follow in the track of the tractor. These trailers may have platform bodies or be equipped with whatever type of box body is desired.

Industrial railways are narrow-gage railways with suitable car equipment, propelled by hand or electricity, gasoline engines or steam engines. Short lines of narrow-gage track with specially designed cars are frequently used for charging or discharging process equipment.

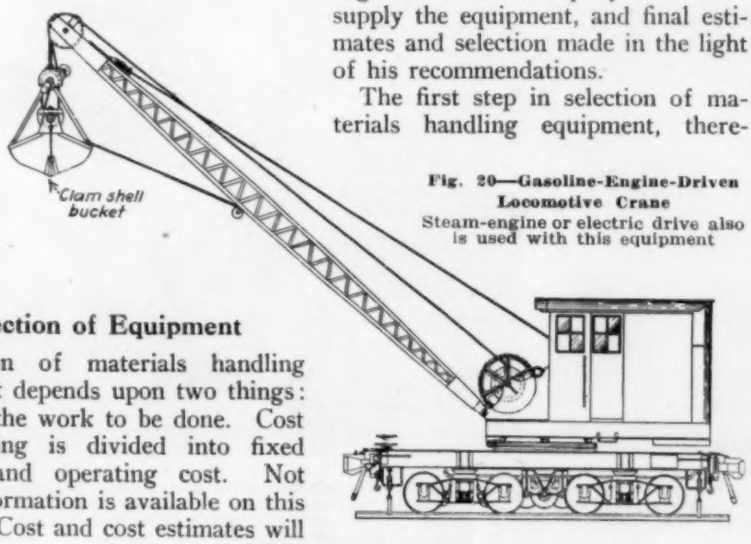


Fig. 20—Gasoline-Engine-Driven Locomotive Crane
Steam-engine or electric drive also is used with this equipment

Selection of Equipment

Selection of materials handling equipment depends upon two things: cost and the work to be done. Cost of handling is divided into fixed charges and operating cost. Not much information is available on this subject. Cost and cost estimates will be discussed at some length at the conclusion of a more specific discussion of type selection.

Preliminary estimates for materials handling equipment should be based on a selection made in accordance with the work to be done. Before purchase of equipment is made, this choice should be reviewed by a competent consulting engineer or by the engineer of the company that is to supply the equipment, and final estimates and selection made in the light of his recommendations.

The first step in selection of materials handling equipment, therefore, is to study the work to be done. From this study the following things are determined:

1. The movement to be made, whether horizontal, vertical or a combination of the two; and the distance covered.
2. The quantity to be moved per hour, per day, or for any other convenient unit of time, both as to weight, number of pieces (if this factor applies), and volume (where that is of importance).
3. How the material is to be delivered to the handling equipment.
4. How the material is to be discharged by the handling equipment.
5. Whether continuous or intermittent flow is possible, including whether the use of storage is available as an aid to obtaining either type of flow.
6. Whether or not the material is in a container, and if so, description of container.
7. Nature of material, as pulverized, lump, etc.

Fig. 21—Top left: Hand-Operated Lift Truck in Which Lift Is Accomplished by Movement of Truck Handle or Tongue

Fig. 22—Top Center: Standard Type of Skid Platform

Fig. 23—Top Right: Skid Platform With Corner Stakes

Fig. 24—Lower Left: Sectional Box or Bin Body on Skid Platform; More Sections May Be Added if Desired

Fig. 25—Lower Center: Slat-Type Body Mounted on Skid Platform

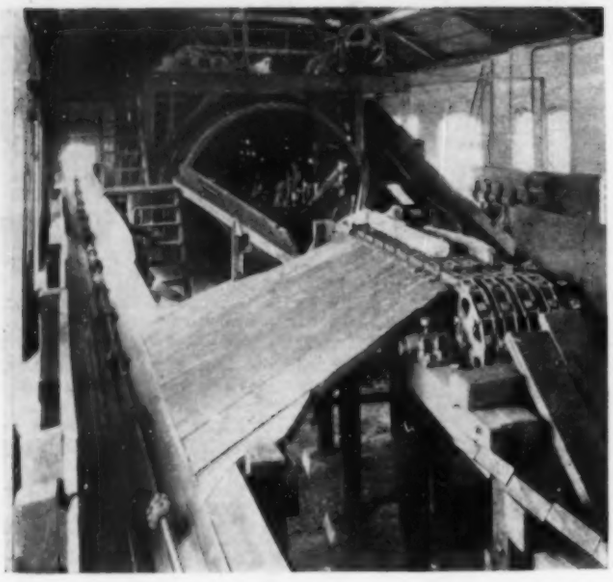
Fig. 26—Lower Right: Rack-Type Body Mounted on Skid Platform

8. Any special conditions of material, as moisture, corrosiveness, or flammability.

There are many special applications of materials handling equipment; as for example, when it becomes practically a part of production equipment. An annealing lehr with a conveyor hearth is a case in point. These special types cannot be discussed, as to selection, in any general consideration of the subject. In any case, such equipment usually is selected by the manufacturer of the production equipment.

Most materials handling installations in the chemical engineering industries fall into certain definite groups, and in these groups possible equipment selections can be indicated that will serve as a guide to the chemical engineer. The tables given below include sufficient examples to enable the engineer to apply the same principles over a much wider range

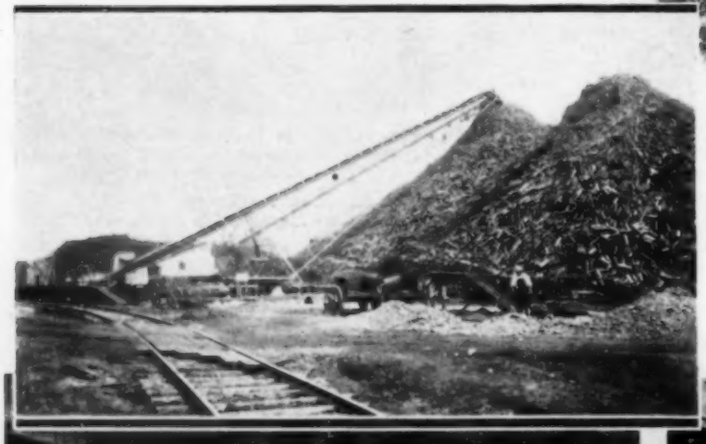
Chains and Cables Tr
Several Types of



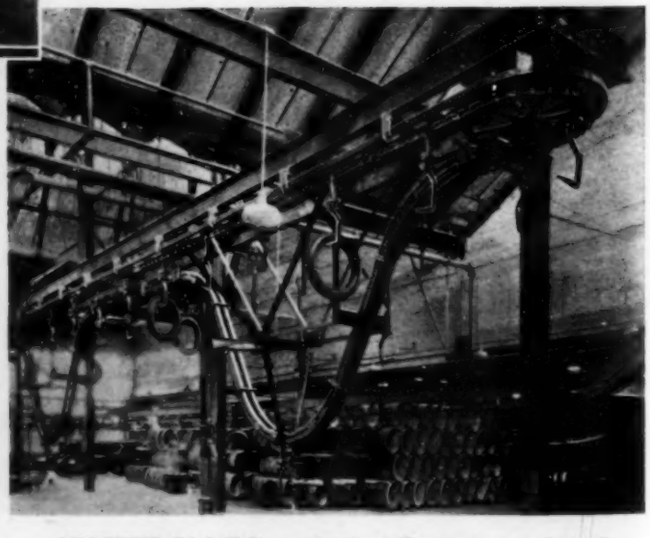
LEFT: Jeffrey cable and drag chain conveyors handle logs from the barking drum in the paper plant of the Gladfelter Company at Spring Cove, Pa. One or the other of these methods is used for conveying logs in most pulp plants.

BELOW: This Jeffrey drag chain conveyor is mounted on a boom which is lowered into the river to receive the logs at the plant of the Alegoquin Paper Company, Ogdensburg, N. Y.

BELOW: Hollingworth & Whitney paper mill at Waterville, Me., uses a Stephens-Adamson stacker for piling logs. The stacker hauls by means of two drag chains and produces a pile 90 ft. high and over 600 ft. long at the rate of 60 cords per hour.



SINGLE-plane overhead trolley conveyor, made by Link-Belt Company, carries tire stock at the Los Angeles plant of Firestone Tire & Rubber Company of California. The chains are carried on trolley rollers.

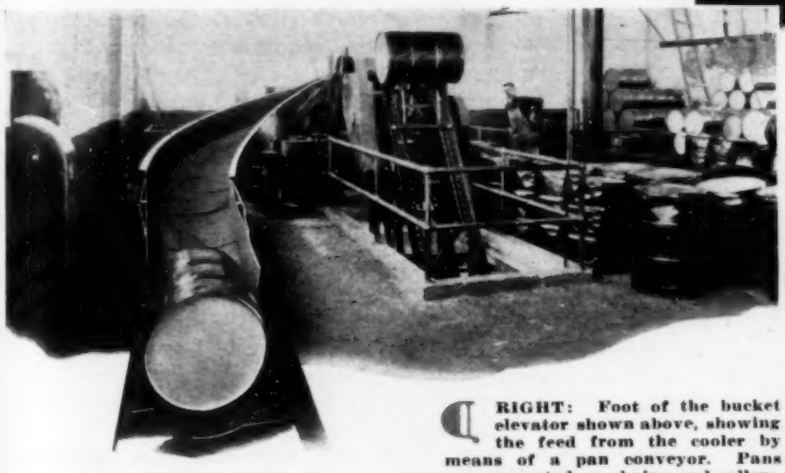


ANOTHER Link-Belt overhead trolley conveyor, but of the two-plane type, also at the Los Angeles Firestone plant. View shows a loading station for cured tires. Note the method of guiding the chains.

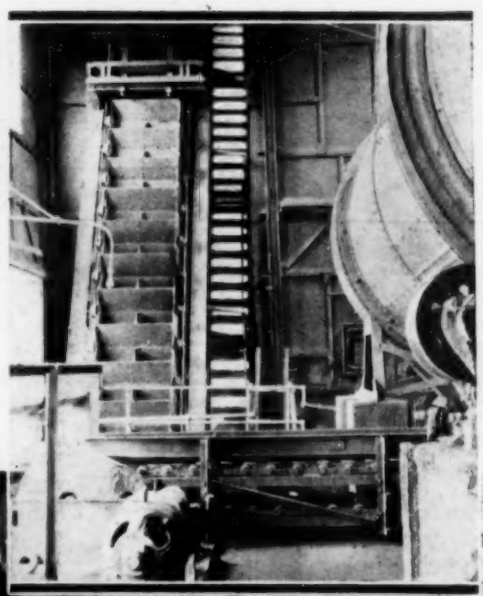
Transport Loads in of Equipment

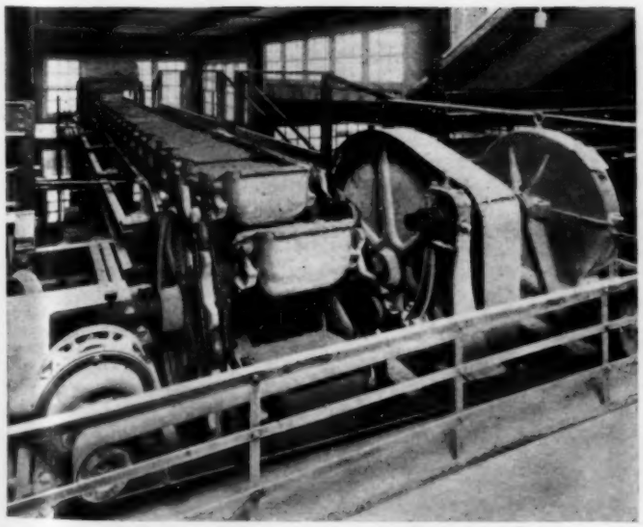
ALPHA Portland Cement Company uses this 400-ton-per-hour bucket elevator, made by the Chain Belt Company, for handling clinker from the kiln cooler. Note the method of drive.

BELOW: Jeffrey drum and barrel elevator and slat conveyor in the plant of the Standard Oil Company of Ohio at Cleveland. The slats are carried on chains.

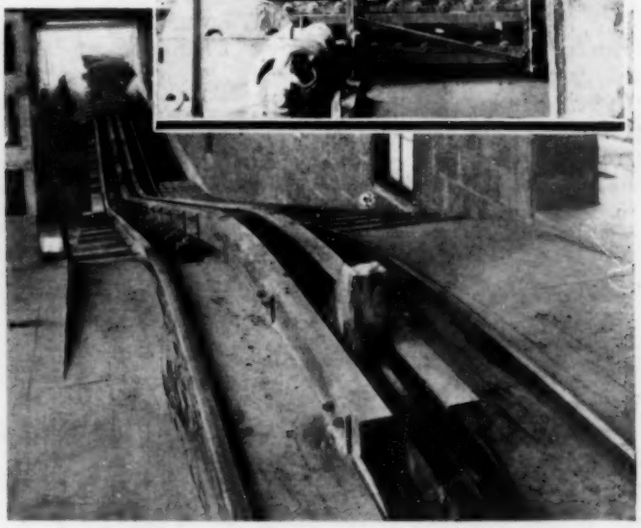


RIGHT: Foot of the bucket elevator shown above, showing the feed from the cooler by means of a pan conveyor. Pans are supported on chains and rollers.





THIS pivoted bucket carrier, made by the Chain Belt Company, is being used to carry clay in the plant of Harbison Walker Company at East Chicago. Buckets may be discharged wherever desired.



CASTALIA Portland Cement Company hauls its quarry cars into the plant by means of a Chain Belt chain conveyor. Lugs attached to the chain at intervals serve to push the cars up the incline.

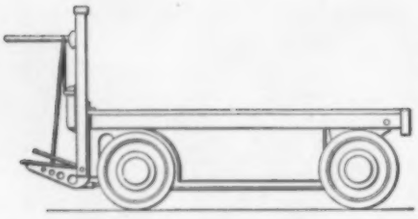


Fig. 27—Electric Storage-Battery, Industrial Truck of Platform Type

of operations. It is to be noted that no account is taken in these tables of the effect of special conditions such as high moisture content, corrosiveness, etc. Where these are present it is advisable to have the material in containers when possible. Where this is not possible resort must be had in general to specially designed equipment. Analysis of the handling problem will readily show if this is necessary, and recourse should then be made to the engineering department of a manufacturing concern making equipment of the type needed.

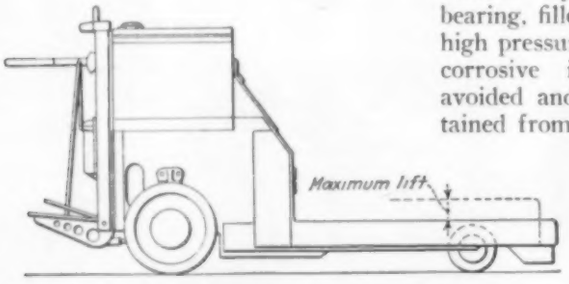


Fig. 28—Electric Storage-Battery, Low-Lift Industrial Truck for Handling Skid Platforms

This subject of special requirements caused by the nature of the material is discussed at some length in the next section.

Special Requirements of the Chemical Engineering Field

Generally speaking, the handling problems encountered in the chemical engineering industries are no different from those encountered elsewhere. Consequently, the general line of materials handling equipment as manufactured for and used by industry in general can be applied in this field.

Five conditions, however, that are found in some handling operations in this field, influence the choice of handling equipment. These are:

1. Corrosion hazard from chemicals or excess moisture.
2. Heat damage hazard from hot materials.
3. Fire or explosion hazards.
4. Poison hazards.
5. Sanitary requirements.

Corrosion from chemicals or excess moisture is the most frequently encountered special condition. It is a hazard most frequently encountered where materials are handled loose. Such corrosion, where present, makes the use of conveyors something to be carefully considered, at least when these are constructed of iron or steel and are unprotected from attack. Frequently, it is best under these conditions to use truck equipment for all handling, for it is simpler in most cases to protect the trucks from damage.

In many cases, however, the corrosion will not seriously shorten the life or effect the usefulness of the conveyor if a certain amount of special construction is undertaken to protect the points where damage would be most serious in results. An example of what this means is the use of gravity roller conveyor in a plant making bleaching powder. The only serious effect of the attack was experienced in the bearings of the rollers. By using a special type of bearing, filled with a lubricant under high pressure, the penetration of any corrosive into the bearings was avoided and satisfactory service obtained from the conveyor.

Another example of special construction to avoid the effects of corrosion is that in which freshly quenched material is handled on an apron conveyor equipped with cast-iron aprons which withstand the effects of the moisture better than steel plate.

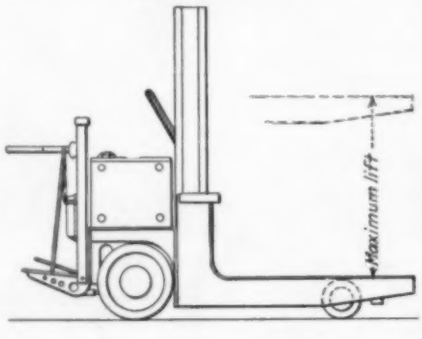
In general, the choice of a means of handling material where a corrosion hazard is encountered means the economic choice between three possible courses:

1. The cheapest type of equipment may be selected, regardless of how seriously it is attacked. This will then be replaced as often as necessary, incurring high replacement charges to offset low first cost.

2. The usual type of handling material for the particular class of handling may be constructed in such a way or of such materials as to avoid high replacement costs, while increasing first costs.

3. The equipment may be protected fully from attack by some such means as the use of containers that adequately seal in the material, or, if the attack is due to a gas or fume, by the use of protecting auxiliary structures and a ventilating system.

Fig. 29 — Electric Storage-Battery, High-Lift Industrial Truck for Handling Skid Platforms, Unloading and Loading, and Storing Containers



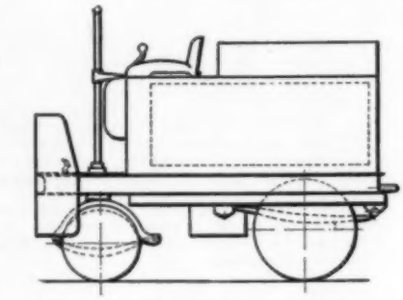


Fig. 30—Electric Storage-Battery, Industrial Tractor

This discussion does not fully cover the manifold possibilities of corrosion attack to which materials handling equipment is exposed in the chemical engineering industries. Each handling problem should be analyzed to ascertain if any corrosion hazard is present and, if one is discovered, its effect on the choice of equipment should be considered along the lines that have been indicated.

Heat damage hazard from hot materials usually is encountered in the handling of furnace or oven products such as coke, clinker, etc. The usual expedient for avoiding such damage is to armor the parts coming into contact with the heat by the use of cast-iron plates, liners, containers, or other parts. Where the heat is too high for safe use of cast iron, a special material should be obtained suitable to the condition.

Fig. 31—Typical Trailer for Use With Tractors

For handling molten materials, usual practice is to use buckets and spouts (chutes) lined with refractory for high temperatures, or of cast iron where the temperatures are moderate.

Fire and explosion hazards are encountered in the handling of materials in certain of the chemical en-

gineering industries. In cases of fire hazard alone, it usually is sufficient to provide for the protection of the material handled from exposure to flame or sparks. As electric equipment or static electricity is the usual source of such hazards, the procedure usually followed is to select equipment which can be operated by motors placed in a sealed space or in an adjacent room, and to provide ground connections that will prevent the accumulation of static charges.

Another type of fire and explosion hazard encountered occurs where flammable dusts are produced. To avoid trouble in such cases, four courses are open. Spaces in which handling is carried out may be ventilated to reduce dust concentrations below the danger point. These spaces may be thoroughly screened from any possible spark or flame. The material may be handled in an atmosphere too low in oxygen to support combustion.

The material may be handled in containers that eliminate the scattering of dust.

Handling of explosives such as gun powders, dynamite, etc., is a hazard restricted to a very few industries. These have made a study of the problem for years and have developed methods that avoid the exposure of the material to jars, jolts, and other shocks. In a problem as special as this type of handling, nothing should be carried out except under the guidance of one expert through long experience in the industry.

Poison hazards encountered in materials handling work are hazards to the operator, not to the equipment. In selecting a handling method where a poison hazard exists, the proper course to follow is to select equipment that can be operated from a distance or automatically; or to so inclose the material in containers, pipe lines or other inclosures that the hazard is avoided.

Sanitary requirements frequently have an effect on the selection of materials handling equipment. In handling food products, or materials such as fats, oils, animal, or vegetable matter there is a possibility of the accumulation of material in or around the equipment that will ferment or spoil, causing a condition that may damage material in process or form a health hazard.

An example of such conditions is found in the dairy industry. Should milk be slopped on the materials handling equipment and allowed to stand in crevices of the equipment, a condition is soon developed that is detrimental to the product and disagreeable to the workers. Therefore, all equipment is thoroughly washed at frequent intervals. This necessitates the use of moisture-proof bearings. This particular feature has become so important with gravity roller conveyors that a standard line of moisture-proof design is now available on the market.

Another example of the effect of sanitary requirements is found in food packing plants, where overhead equipment or trolley conveyors are preferred, in order that the floor may be clear and thoroughly accessible for cleaning.

Choice of Materials Handling Equipment

To classify the solutions of handling problems, Tables I to XII are presented here, showing three general divisions into which all handling problems fall: large quantity; medium quantity; small quantity. With these factors, such other factors as type of flow, direction of flow, and condition of material are considered. The tables present only such choice as might be made to satisfy ordinary conditions, wherein no special difficulties are encountered. Note that the length of the movement which is to be made has an effect on selection and that it is frequently best practice, if long distances are to be covered, to use truck equipment or industrial railways.

Following these tables are other tables giving data as to capacity, horsepower, and first cost of frequently used types of materials handling equipment. The type most usually selected for a given handling job is indicated in Tables I to XII by an asterisk (*).

Belt Conveyors

Table XIII gives general information that will assist in the selection of belt conveyors for preliminary estimating purposes. The table does not fully cover the subject but suggests the ranges of belt sizes, speeds, capacities, and size of material handled.

Capacities given assume uniform loading with feeder. Extra width should be provided for peak loads. Speeds should be governed by size of material, method of loading, incline of conveyor, if any, and other affecting factors.

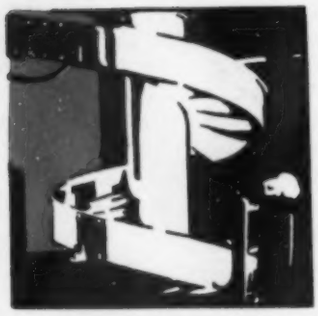
Horsepower required to drive the belt, taking into consideration the weight of the belt, is figured from the following formula (Link-Belt Company):

$$\text{Hp.} = \frac{KL}{1{,}000}\left(T + \frac{SB}{16}\right) + \frac{TH}{990} + P$$

Table I—Large Quantity Handled in Continuous Flow

(Over 100 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy, broken or crushed nature	Belt conveyors* Apron or pan conveyors Pneumatic conveyors	Bucket elevators* V-Bucket carriers Pneumatic conveyors	Chutes* V-Bucket carriers	Belt conveyors* Chutes Pneumatic conveyors Solids pumps Pivoted bucket carriers V-Bucket carriers
Bulk material of finely divided or pulverized nature	Pneumatic conveyors* Screw conveyors Belt conveyors	Pneumatic conveyors* Bucket elevators V-Bucket carriers	Chutes* Pneumatic conveyors	Pneumatic conveyors* Solids pumps Screw conveyors Chutes
Containers such as bags or sacks	Gravity roller conveyors* Platform conveyors Slat conveyors Belt conveyors	Chain elevators* Belt elevators Tray elevators	Chutes* Spiral chutes Roller spirals	Gravity roller conveyors* Live roller conveyors Belt conveyors Platform conveyors Slat conveyors Chutes
Containers such as barrels or drums	Slat conveyors* Chain conveyors Platform conveyors Gravity roller conveyors	Barrel elevators* Chain elevators	Barrel elevators* Chain elevators Roller spirals Chutes	Slat conveyors* Chain conveyors Platform conveyors Chutes
Containers such as boxes or packages	Chain conveyors* Gravity roller conveyors* Belt conveyors Platform conveyors Slat conveyors Push-bar conveyors	Package elevators* Chain elevators Belt elevators	Spiral chutes* Package elevators Chutes Roller spirals	Chain conveyors* Gravity roller conveyors* Belt conveyors Push-bar conveyors Chutes Live roller conveyors
Pieces such as logs, tires, pulp laps, large lumps	Chain-trolley conveyors* Chain or cable conveyors Apron or pan conveyors Gravity roller conveyors Belt conveyors	Chain elevators* Belt elevators Tray elevators	Spiral chutes* Chutes	Chain trolley conveyors* Chain or cable conveyors Apron or pan conveyors Gravity roller conv'y'rs Chutes



where K is a power constant from Table XIV; L is length of conveyor (between pulley centers) in feet; T is tons per hour of material; S is speed of belt in feet per minute; B is weight of belt in pounds per feet, from Table XV; H is rise of belt in feet (if belt is inclined), and P is horsepower for tripper (if used), from Table XIV.

To the above calculation add:

1. For horsepower consumed by the terminals (head and foot shafts only), 20 per cent for conveyors under 50-ft. centers; 10 per cent for conveyors under 100-ft. centers; 5 per cent for conveyors under 150-ft. centers.

2. For horsepower consumed by countershaft drives, 10 per cent of total for each speed reduction through cast-tooth gears, or 5 per cent of total for each speed reduction through cut gears.

List prices and weights for standard, three-roll, anti-friction trough-ing idlers in unit stands, with return for conveyor belt, are given in Table XVI. There are idlers available at higher and lower prices than given in the table, depending on design and purpose. Those given will serve as a guide in estimating, when used with Table XVII, giving spacing of idlers.

In estimating belt conveyor costs, allowance should also be made for head and foot pulleys, take-up, and drive. Where trippers, unloaders, and feeders are used, these also should be included.

Table III—Large Quantity Handled; Intermittent Demand With Storage to Give Continuous Flow Effect

(Over 100 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy, broken or crushed nature	Belt conveyors* Pneumatic conveyors Solids pumps Apron or pan conveyors Scraper or drag conveyors	Bucket elevators* V-Bucket carriers Pneumatic conveyors	Chutes* V-Bucket carriers	Belt conveyors* Pneumatic conveyors Solids pumps Chutes V-Bucket carriers Pivoted bucket carriers
Bulk material of finely divided or pulverized nature	Pneumatic conveyors* Belt conveyors Flight conveyors Screw conveyors Solids pumps	Pneumatic conveyors* Bucket elevators V-Bucket carriers	Chutes* V-Bucket carriers	Pneumatic conveyors* Screw conveyors Solids pumps Chutes
Containers such as bags or sacks	Gravity roller conveyors* Belt conveyors Platform conveyors Slat conveyors	Chain elevators* Belt elevators Tray elevators	Chutes* Spiral chutes Roller spirals	Gravity roller conveyors* Live roller conveyors Belt conveyors Platform conveyors Slat conveyors Chutes
Containers such as barrels or drums	Slat conveyors* Chain conveyors Platform conveyors Gravity roller conveyors	Barrel elevators* Chain elevators	Barrel elevators* Chain elevators Roller spirals Chutes	Slat conveyors* Chain conveyors Platform conveyors Chutes
Containers such as boxes or packages	Chain conveyors* Gravity roller conveyors* Belt conveyors Platform conveyors Slat conveyors Pusher-bar conveyors	Package elevators* Chain elevators Belt elevators	Spiral chutes* Chutes Roller spirals Package elevators	Chain conveyors* Gravity roller conveyors* Belt conveyors Pusher-bar conveyors Chutes
Pieces such as logs, tires, pulp laps, large lumps	Chain trolleys* Chain or cable conveyors* Apron or pan conveyors Gravity roller conveyors	Chain elevators* Belt elevators Tray elevators	Spiral chutes* Chutes	Chain trolleys* Chain or cable conveyors* Apron or pan conveyors Gravity roller conveyors Chutes

Table II—Large Quantity Handled in Intermittent Flow

(Over 100 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy, broken or crushed nature	Dragline scrapers* Industrial railways* Tractors and trailers Traveling cranes Monorail trolleys (motor-driven)	Skip hoists* Platform elevators	Chutes*	Traveling cranes* (power) Monorail trolleys (motor-driven) Locomotive cranes
Bulk material of finely divided or pulverized nature	Industrial railways* Tractors and trailers* Monorail trolleys (motor-driven)	Skip hoists* Platform elevators	Chutes*	Traveling cranes* (power) Monorail trolleys (motor-driven)
Containers such as bags or sacks	Tractors and trailers* Industrial railways Traveling cranes Monorail trolleys (motor-driven)	Drum hoists* Platform elevators Stationary cranes	Chutes* Platform elevators Drum hoists Stationary cranes	Traveling cranes* (power) Monorail trolleys (motor-driven)
Containers such as barrels or drums	Tractors and trailers* Industrial railways	Platform elevators* Stationary cranes Drum hoists	Platform elevators* Drum hoists Stationary cranes	Monorail trolleys* (motor-driven) Traveling cranes (power)
Containers such as boxes or packages	Tractors and trailers* Industrial railways Traveling cranes Monorail trolleys (motor-driven)	Platform elevators* Stationary cranes Drum hoists	Chutes* Platform elevators Drum hoists Stationary cranes	Monorail trolleys* (motor-driven) Traveling cranes (power)
Pieces such as logs, tires, pulp laps, large lumps	Monorail trolleys* (motor-driven) Tractors and trailers* Industrial railways Traveling cranes	Platform elevators* Stationary cranes Drum hoists	Chutes* Platform elevators	Monorail trolley* (motor-driven) Traveling cranes (power) Locomotive cranes

Bucket Elevators

In Table XVIII are given the speed, horsepower, and capacity of centrifugal-discharge bucket elevators with malleable-iron buckets spaced on single-strand chain and enclosed in steel casings. These are a commonly used type of elevator.

Horsepower of bucket elevators may be figured from the equations:

$$\text{Horsepower} = \frac{HT}{500}$$

for spaced buckets and digging boots;

$$\text{Horsepower} = \frac{HT}{550}$$

for continuous buckets with loading leg. Here H is the center-to-center distance in feet and T is tons per hour.

Cast-iron elevator boots vary in list price from $60 to $180 for the range of sizes given in Table XVIII, while steel boots vary from $110 to $230. Buckets of standard weight

range from $0.35 to $1.35 for these sizes.

An elevator with 6x4-in. buckets, 30 ft. from center to center, complete with boot and head, including drive gears and pulleys, will list at $350, with $4 added for each extra foot in length, when no casing is included and buckets are mounted on rubber belting in place of chain. The same type of elevator, but with 16x8-in. buckets, will list at $1,100. These figures will indicate the range in first cost for such equipment.

Cost of driving equipment can be estimated from horsepower requirements.

Chain Conveyors

Chain conveyors, whether of the type that runs under the load, such as log conveyors, or of the type that runs in guides with attachments to carry the load, consist of an appropriate type of chain, with sprockets, attachments, guides and supports. Table XIX gives data for a style of chain used for roller-chain conveyors where the load is supported on attachments. These attachments vary in price from $3 to $6 per foot, assembled in chain every link.

Data for chain used for directly supporting the load do not differ much from the above, except that such chain usually has a higher working strength. List prices of cast-iron sprocket wheels for these chains vary from about $7 for a 6-in. pitch diameter to about $85 for a 58-in. pitch diameter. Drive and supports must also be included in any estimate.

Table V—Medium Quantity Handled in Continuous Flow

(10 to 100 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy, broken or crushed nature	Belt conveyors* Apron or pan conveyors Drag chain conveyors	Bucket elevators*	Chutes*	Belt conveyors* Chutes Flight conveyors Apron or pan conveyors V-Bucket carriers Pivoted bucket carriers
Bulk material of finely divided or pulverized nature	Solids pumps* Pneumatic conveyors* Belt conveyors Scraper conveyors Flight conveyors Screw conveyors	Pneumatic conveyors* Bucket elevators	Chutes* Pneumatic conveyors	Solids pumps* Pneumatic conveyors* Chutes Screw conveyors Flight conveyors
Containers such as bags or sacks	Belt conveyors* Gravity roller conveyors* Chain trolleys	Chain elevators* Belt elevators Tray elevators	Chutes* Spiral chutes Roller spirals	Belt conveyors* Gravity roller conveyors* Live roller conveyors Chutes
Containers such as barrels or drums	Chain conveyors* Gravity roller conveyors	Barrel elevators* Chain elevators	Barrel elevators* Chain elevators Roller spirals Chutes	Chain conveyors* Chutes
Containers such as boxes or packages	Chain conveyors* Gravity roller conveyors* Chain trolleys Belt conveyors	Package elevators* Chain elevators Belt elevators	Spiral chutes* Package elevators Chutes Roller spirals	Gravity roller conveyors* Chain conveyors* Belt conveyors Chain trolleys Pusher-bar conveyors Chutes
Pieces such as logs, tires, pulp laps, large lumps	Chain trolleys* Chain or cable conveyors* Belt conveyors Gravity roller conveyors	Chain elevators* Belt elevators Tray elevators	Spiral chutes* Chutes	Chain trolleys* Chain or cable conveyors* Pan conveyors Gravity roller conveyors Chutes

Chain Trolley Conveyors

Chain trolley data are similar to those for chain conveyors. The lighter, less expensive chains used are balanced in cost by the greater expense of attachments, including the trolley hangers and rollers. Table XX gives size and loading data on these trolleys.

Table IV—Large Quantity Handled; Continuous Demand With Storage to Give Intermittent Flow Effect

(Over 100 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy, broken or crushed nature	Dragline scrapers* Industrial railways* Tractors and trailers Traveling cranes Monorail trolleys (motor-driven)	Skip hoists* Platform elevators	Chutes*	Traveling cranes* (power) Monorail trolleys (motor-driven) Locomotive cranes
Bulk material of finely divided or pulverized	Tractors and trailers* Industrial railways* Monorail trolleys (motor-driven)	Skip hoists* Platform elevators	Chutes*	Traveling cranes* (power) Monorail trolleys (motor-driven)
Containers such as bags or sacks	Tractors and trailers* Industrial railways Traveling cranes Monorail trolleys (motor-driven)	Platform elevators* Stationary cranes Drum hoists	Chutes* Platform elevators Drum hoists Stationary cranes	Traveling cranes* (power) Monorail trolleys (motor-driven)
Containers such as barrels or drums	Tractors and trailers* Industrial railways	Platform elevators* Stationary cranes Drum hoists	Platform elevators* Drum hoists Stationary cranes	Monorail trolleys* (motor-driven) Traveling cranes (power)
Containers such as boxes or packages	Tractors and trailers* Industrial railways Traveling cranes (power) Monorail trolleys (motor-driven)	Platform elevators* Stationary cranes Drum hoists	Chutes* Platform elevators Drum hoists Stationary cranes	Monorail trolleys* (motor-driven) Traveling cranes (power)
Pieces such as logs, tires, pulp laps, large lumps	Monorail trolleys* (motor-driven) Tractors and trailers* Industrial railways Traveling cranes	Platform elevators* Stationary cranes Drum hoists	Chutes* Platform elevators	Monorail trolleys* (motor-driven) Traveling cranes (power) Locomotive cranes

Apron, Pan, Slat, and Platform Conveyors

List prices of apron, pan, slat, and platform conveyors, are determined as are those of any other chain conveyor, as these conveyors are single or double-strand chain conveyors with the pans, aprons, slats or platforms serving as attachments.

Horsepower required to drive such a conveyor is given approximately by the following formula, which does not take into account losses due to friction and other factors, that result

Table VI—Medium Quantity Handled in Intermittent Flow

(10 to 100 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy, broken or crushed nature	Monorail trolleys* (motor-driven) Tractors and trailers Power trucks with skids	Skip hoists* Platform elevators Drum hoists	Platform elevators* Drum hoists	Monorail trolleys* (motor-driven) Traveling cranes (power)
Bulk material of finely divided or pulverized nature	Power trucks with skids* Tractors and trailers Monorail trolleys (motor-driven)	Platform elevators* Skip hoists Drum hoists	Platform elevators* Drum hoists	Monorail trolleys* (motor-driven) Traveling cranes (power)
Containers such as bags or sacks	Power trucks with skids* Tractors and trailers* Platform trucks (power)	Drum hoists* Platform elevators Stationary cranes Chain hoists (power)	Drum hoists* Chain hoists (power) Platform elevators Stationary cranes	Monorail trolleys* (motor-driven) Traveling cranes (power)
Containers such as barrels or drums	Power trucks with skids* Tractors and trailers* Platform trucks (power)	Platform elevators* Drum hoists Stationary cranes Chain hoists (power)	Platform elevators* Drum hoists Stationary cranes Chain hoists (power)	Monorail trolleys* (motor-driven) Traveling cranes (power)
Containers such as boxes or packages	Power trucks with skids* Tractors and trailers* Platform trucks (power)	Platform elevators* Drum hoists Stationary cranes Chain hoists (power)	Platform elevators* Drum hoists Stationary cranes Chain hoists (power)	Monorail trolleys* (motor-driven) Traveling cranes (power)
Pieces such as logs, tires, pulp laps, large lumps	Power trucks with skids* Tractors and trailers* Platform trucks (power) Monorail trolleys (motor-driven)	Chain hoists* (power) Platform elevators Drum hoists Stationary cranes	Chain hoists* (power) Platform elevators Drum hoists Stationary cranes	Monorail trolleys* (motor-driven) Traveling cranes (power)

in a higher horsepower requirement. Note, in figuring loads, that the formula is for horsepower of the headshaft, so that weight of conveyor as well as of material should be taken. Also note that inclined conveyors of this type will require more horsepower for a given load than horizontal conveyors.

$$\text{Hp.} = \frac{\text{Load in lb.} \times \text{speed in ft. per min.}}{33{,}000}$$

Capacities for various widths of apron or pan conveyors are given in Table XXI. This table is based on the assumption that the conveyor is uniformly loaded to 75 per cent of the maximum cross section (net width of carrying surface, in inches, multiplied by height of sides, in inches), and traveling at a speed of 10 ft. per minute. For other widths of carrying surface, heights of sides, and speeds, than those listed, the capacities should be figured in direct proportion to the varying dimensions; for instance, if the speed is 50 ft. per minute, multiply the listed capacity by 5.

Capacities for slat or platform conveyors are given in Table XXII. In this table several package weights are given for each conveyor width Stronger chain is used as these package weights increase.

In estimating the cost of apron, pan, slat and platform conveyors, it should be borne in mind that, in addition to the cost of the chain and attachments, the cost of the sprockets, driving equipment and supporting structure must be included.

Chain and Tray Elevators

Barrel, package, bag or tray elevators are double-strand chain conveyors with various types of attachment for holding such containers. either in ascent or descent. Data for estimate will be similar to those used for other types of chain conveyor, except that the special attachments, for holding the load, coming in sets of two, one for each chain strand, will range in cost from $12 to $30, depending on their purpose.

More elaborate conveyors of this type, with automatic unloading, loading, and control attachments are available. If these are to be used. preliminary data should be obtained from the manufacturers.

Bucket Carriers

Pivoted bucket and V-bucket carriers are special designs of chain conveyor, similar in the main to bucket elevators, but having upper and lower horizontal runs in addition to the upward and downward runs of the bucket elevator.

Capacities of pivoted bucket carriers are given in Table XXIII. This table does not include horsepower requirements. Horsepower is given in Table XXIV for V-bucket carriers and will not vary greatly for pivoted bucket carriers of similar length and capacity. Prices for estimate purposes may be obtained from the data

Table VII—Medium Quantity Handled; Intermittent Demand With Storage to Give Continuous Flow Effect

(10 to 100 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy, broken or crushed nature	Belt conveyors* Apron or pan conveyors Drag chain conveyors	Bucket elevators*	Chutes*	Belt Conveyors* Chutes Flight conveyors Apron or pan conveyors V-Bucket carriers Pivoted bucket carriers
Bulk material of finely divided or pulverized nature	Pneumatic conveyors* Solids pumps* Belt conveyors Scraper conveyors Flight conveyors Screw conveyors	Pneumatic conveyors* Bucket elevators	Chutes* Pneumatic conveyors	Solids pumps* Pneumatic conveyors* Chutes Screw conveyors Flight conveyors
Containers such as bags or sacks	Belt conveyors* Gravity roller conveyors* Chain trolleys	Chain elevators* Belt elevators Tray elevators	Chutes* Spiral chutes Roller spirals	Belt conveyors* Gravity roller conveyors* Live roller conveyors Chutes
Containers such as barrels or drums	Chain conveyors* Gravity roller conveyors	Barrel elevators* Chain elevators	Barrel elevators* Chain elevators Roller spirals Chutes	Chain conveyors* Chutes
Containers such as boxes or packages	Chain conveyors* Gravity roller conveyors* Belt conveyors Chain trolleys	Package elevators* Belt elevators Chain elevators	Spiral chutes* Package elevators Roller spirals Chutes	Chain conveyors* Gravity roller conveyors* Belt conveyors Pusher-bar conveyors Chutes Chain trolleys
Pieces such as logs, tires, pulp laps, large lumps	Chain trolleys* Chain or cable conveyors* Belt conveyors Gravity roller conveyors	Chain elevators* Belt elevators Tray elevators	Spiral chutes* Chutes	Chain trolleys* Chain or cable conveyors* Pan conveyors Gravity roller conveyors Chutes

given in Table XXIV, for V-bucket carriers. Note that these list prices do not include the driving mechanism.

Flight or Scraper Conveyors

These conveyors are also of the two-strand chain type. In estimating cost, data given for chain conveyors should be followed. Costs for scraper flights and for steel plate troughs will be given below.

Capacities given in Table XXV are figured on the basis of dry coal weighing 50 lb. per cubic foot. Capacities differ for other materials of other densities or angles of repose. The capacities given are about 80 per cent of those that would be obtained with perfect loading.

Horsepower requirements for each 100-ft. centers and sufficient for inclines, varies from about 2.5 for the first-flight size to about 10 for the largest, for horizontal conveyors. Inclined conveyors will require more if the quantity handled is not cut down somewhat. Note that these figures are for coal at 50 lb. per cubic foot.

Scraper flights vary in list price from $0.45 for a 12-gage, 4 x 10-in. flight to $2.45 for a 10 x 24-in. flight, $\frac{5}{16}$ in. thick. Troughs vary in list prices as follows: For 10-gage shallow troughs, from $13 per 10-ft. length to $21.20 for 10-ft. length, over the same range of flight sizes as in Table XXV. For deep troughs, $\frac{1}{4}$ in. thick, cost varies from $19.50 per 10-ft. length to $37.80 per 10-ft. length, for this same range of sizes.

Table IX—Small Quantity Handled in Continuous Flow

(0 to 10 tons per hours) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizonta and Vertical Movement
Bulk material of lumpy, broken or crushed nature	Belt conveyors* Drag chain conveyors Scraper conveyors	Bucket elevators*	Chutes*	Belt conveyors* Chutes
Bulk material of finely divided or pulverized nature	Belt conveyors* Pneumatic conveyors Solids pumps	Bucket elevators* Pneumatic conveyors	Chutes* Pneumatic conveyors	Belt conveyors* Chutes Pneumatic conveyors Solids pumps
Containers such as bags or sacks	Belt conveyors* Gravity roller conveyors*	Chain elevators* Belt elevators	Chutes* Spiral chutes	Belt conveyors* Gravity roller conveyveyors* Chutes
Containers such as barrels or drums	Chain conveyors* Gravity roller conveyors	Chain elevators*	Chutes*	Chain conveyors* Chutes Gravity roller conveyors
Containers such as boxes or packages	Gravity roller conveyors* Belt conveyors Chain trolleys	Chain elevators* Belt elevators	Spiral chutes* Chutes	Gravity roller conveyors* Belt conveyors Chain conveyors Chain trolleys Chutes
Pieces such as logs, tires, pulp laps, large lumps	Chain or cable conveyors* Chain trolleys* Gravity roller conveyors Belt conveyors	Chain elevators* Belt elevators	Spiral chutes* Chutes	Chain or cable conveyors* Chain trolleys* Belt conveyors Chutes Gravity roller conveyors

Drag Chain Conveyors

Drag chain conveyors are chains running in a trough, generally of wood, and propelling material that lies upon them along the trough. No flights are used, contact with the chain being sufficient to move the class of materials, such as ashes, on which drag chains are used. In general, these conveyors should be estimated just as other chain conveyors are. Data as to capacities and speeds are given in Table XXVI. Horsepower required for these conveyors can be estimated from the data given and the weight of the material, due allowance being made for friction. Cost can be estimated by estimating the cost of the structure, sprockets and drive, and to that adding list prices of $1.80, $2.50, or $3.40 per foot for the chain in the three cases given in the table.

Table VIII—Medium Quantity Handled; Continuous Demand With Storage to Give Intermittent Flow Effect

(10 to 100 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy broken, or crushed nature	Monorail trolleys* (power) Tractors and trailers Power trucks with skids	Skip hoists* Platform elevators Drum hoists	Platform elevators* Drum hoists	Monorail trolleys* (power) Traveling cranes (power)
Bulk material of finely divided or pulverized nature	Power trucks with skids* Tractors and trailers Monorail trolleys (power)	Platform elevators* Skip hoists Drum hoists	Platform elevators* Drum hoists	Monorail trolleys* (power) Traveling cranes (power)
Containers such as bags or sacks	Power trucks with skids* Tractors and trailers* Platform trucks (power)	Drum hoists* Platform elevators Stationary cranes Chain hoists (power)	Drum hoists* Platform elevators Stationary cranes Chain hoists (power)	Monorail trolleys* (power) Traveling cranes (power)
Containers such as barrels or drums	Power trucks with skids* Tractors and trailers* Platform trucks (power)	Platform elevators* Drum hoists Stationary cranes Chain hoists (power)	Platform elevators* Drum hoists Stationary cranes Chain hoists (power)	Monorail trolleys* (power) Traveling cranes (power)
Containers such as boxes or packages	Power trucks with skids* Tractors and trailers* Platform trucks (power)	Platform elevators* Drum hoists Stationary cranes Chain hoists (power)	Platform elevators* Drum hoists Stationary cranes Chain hoists (power)	Monorail trolleys* (power) Traveling cranes (power)
Pieces such as logs, tires, pulp laps, large lumps	Power trucks with skids* Tractors and trailers* Platform trucks (power) Monorail trolleys (power)	Chain hoists* (power) Platform elevators Drum hoists Stationary cranes	Chain hoists* (power) Platform elevators Drum hoists Stationary cranes	Monorail trolleys* (power) Traveling cranes (power)

Screw Conveyors

Sizes, capacities and speeds usual with screw conveyors are listed in Table XXVII. List prices are in Table XXVIII. The horsepower required to drive a screw conveyor can be determined by applying the following formula:

$$\text{Horsepower} = \frac{W \times L \times C}{33{,}000}$$

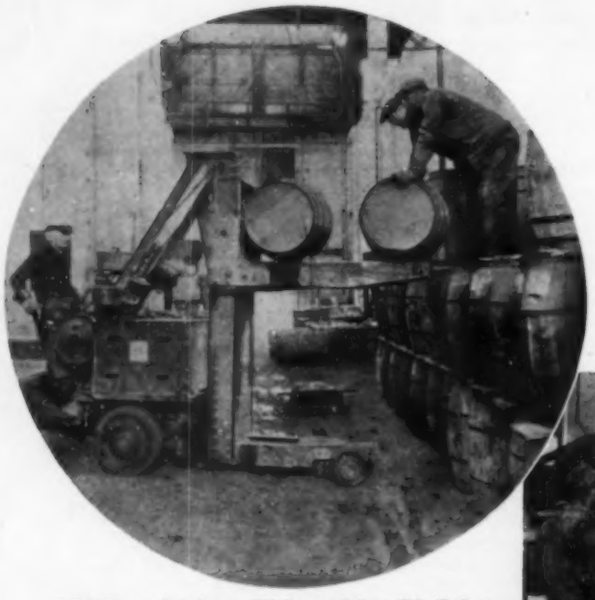
where W is weight of material moved in pound per minute; L is length of conveyor in feet; C is 1.3 for grain and similar material; 2.5 for coal, cement, etc.; and 4.0 for ashes, sand, and gravel. Horsepower obtained by this formula will be conservative with due allowances for ordinary misalignment and other variable factors.

For this same range of screw conveyor sizes, the list price ranges given in Table XXIX may be used for estimation purposes.

Gravity Roller Conveyors

Gravity roller conveyors come in two general types and several sizes and bearing designs. The two types

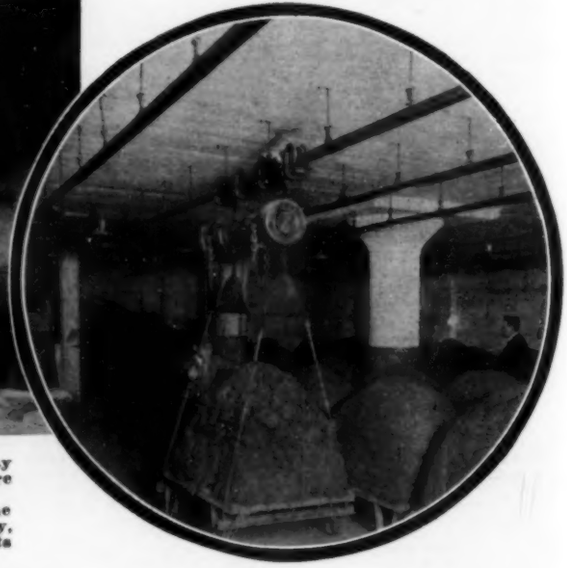
Trucks and Monorails Are Versatile Carriers



ABOVE and below: High- and low-lift Baker electric trucks, showing versatility of this type of equipment. The high-lift is stacking barrels of pigments in a paint plant and the low-lift is being used in carrying pulp laps to a car.

ABOVE: Another way to handle pulp laps; Stuebing lift truck in the plant to the Champion Coated Paper Company at Hamilton, Ohio, serving the beaters.

RIGHT: Mercury gasoline-driven tractor hauling trailers loaded with rubber in the plant of E. H. Clapp Rubber Company at Boston.



ABOVE: One operator handles 500 tons of paper rolls per day at the plant of Taggart Brothers in Oswego, N. Y. Rolls are carried and stacked by a cab-controlled Cleveland Tramrail.

RIGHT: One man easily handles 2 tons of clay at one time in the aging cellars of the Los Angeles Pressed Brick Company, using this hand-operated Cleveland Tramrail with chain hoists and sling for lifting the skid platforms.

are two-rail and three-rail. Two-rail conveyors have one series of rollers held between frame rails on either side. Three-rail types have two sets of rollers, parallel, and held between three frame rails, one being in the center between the two sets of rollers.

Straight sections of roller conveyor are 4 or 8 ft. long as desired. Special lengths, curves, switches, etc., are made to order.

Light-duty roller conveyor has rollers of 1 in. outside diameter on light ball bearings. Length of rollers ranges from 4 in. to 20 in. for the two-rail type and from 6 in. to 20 in. for three-rail. Capacity is 20 lb. continuous load for each roller.

Table XI—Small Quantity Handled; Intermittent Demand With Storage to Give Continuous Flow Effect

(0 to 10 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy, broken or crushed nature	Belt conveyors* Drag chain conveyors Scraper conveyors	Bucket elevators*	Chutes*	Belt conveyors* Chutes
Bulk material of finely divided or pulverized nature	Belt conveyors* Pneumatic conveyors Solids pumps	Bucket elevators* Pneumatic conveyors	Chutes* Pneumatic conveyors	Belt conveyors* Chutes Pneumatic conveyors Solids pumps
Containers such as bags or sacks	Belt conveyors* Gravity roller conveyors*	Chain elevators* Belt elevators	Chutes* Spiral chutes	Belt conveyors* Gravity roller conveyors* Chutes
Containers such as barrels or drums	Chain conveyors* Gravity roller conveyors	Chain conveyors*	Chutes*	Chain conveyors* Chutes Gravity roller conveyors
Containers such as boxes or packages	Gravity roller conveyors* Belt conveyors Chain trolleys	Chain elevators* Belt elevators	Spiral chutes* Chutes	Gravity roller conveyors* Chain trolleys Belt conveyors Chain conveyors Chutes
Pieces such as logs, tires, pulp laps, large lumps	Chain or cable conveyors* Chain trolleys* Belt conveyors Gravity roller conveyors	Chain elevators* Belt elevators	Spiral chutes* Chutes	Chain or cable conveyors* Chain trolleys* Belt conveyors Chutes Gravity roller conveyors

Standard-duty roller conveyor has rollers of $1\frac{5}{8}$-in., $1\frac{7}{8}$-in., or $3\frac{1}{4}$-in. diameter on ball bearings. Length of roller is 4 in. to 24 in. for the two-rail type and 6 in. to 24 in. for the three-rail type. Capacity is 100 lb. continuous load for each roller.

Heavy-duty roller conveyor with rollers from $2\frac{9}{16}$-in. to 4-in. diameter and capacities up to 5,000 lb. continuous load per roller is also made.

First cost of gravity roller conveyors runs from $1 per foot to $25 per foot, depending on size, load capacity, and roller spacing.

Table X—Small Quantity Handled in Intermittent Flow

(0 to 10 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy, broken or crushed nature	Hand trucks with skids* Power trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Platform elevators* (portable) Drum hoists	Platform elevators* (portable) Drum hoists	Monorail trolleys* (hand) Traveling cranes (hand)
Bulk material of finely divided or pulverized nature	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Platform elevators* (portable) Drum hoists	Platform elevators* (portable) Drum hoists	Monorail trolleys* (hand) Traveling cranes (hand)
Containers such as bags or sacks	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Monorail trolleys* (hand) Traveling cranes (hand)
Containers such as barrels or drums	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Monorail trolleys* (hand) Traveling cranes (hand)
Containers such as boxes or packages	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Platform elevators* (portable) Drum hoists Chain hoists (power or hand)	Platform elevators* (portable) Drum hoists Chain hoists (power or hand)	Monorail trolleys* (hand) Traveling cranes (hand)
Pieces such as logs, tires, pulp laps, large lumps	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Monorail trolleys* (hand) Traveling cranes (hand)

Pneumatic Conveyors

Capacities and list prices of pneumatic handling systems should be obtained from a manufacturer for each case that arises. For estimate purposes it may be assumed that in a suction system, to move 20 tons per hour through 50 ft. requires 50 hp.; the same quantity through 150 ft. requires 75 hp.; and through 250 ft. requires 90 hp.

An installation for moving 10 tons per hour of material weighing 40 lb. per cubic foot, over a distance of 300 ft. cost approximately $10,000. The

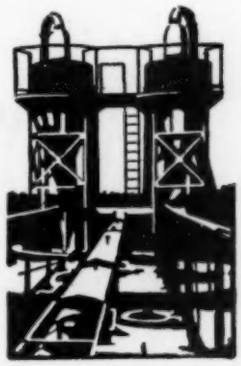


Table XII—Small Quantity Handled; Continuous Demand With Storage to Give Intermittent Flow Effect

(0 to 10 tons per hour) *Usual Choice

Material Handled	Horizontal Movement	Vertical Upward Movement	Vertical Downward Movement	Combined Horizontal and Vertical Movement
Bulk material of lumpy, broken, or crushed nature	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Platform elevators* (portable) Drum hoists	Platform elevators* (portable) Drum hoists	Monorail trolleys* (hand) Traveling cranes (hand)
Bulk material of finely divided or pulverized nature	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Platform elevators* (portable) Drum hoist	Platform elevators* (portable) Drum hoists	Monorail trolleys* (hand) Traveling cranes (hand)
Containers such as bags or sacks	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Monorail trolleys* (hand) Traveling cranes (hand)
Containers such as barrels or drums	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Monorail trolleys* (hand) Traveling cranes (hand)
Containers such as boxes or packages	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Platform elevators* (portable) Drum hoists Chain hoists (power or hand)	Platform elevators* (portable) Drum hoists Chain hoists (power or hand)	Monorail trolleys* (hand) Traveling cranes (hand)
Pieces such as logs, tire-pulp laps, large lumps	Power trucks with skids* Hand trucks with skids* Platform trucks (hand or power) Monorail trolleys (hand)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Chain hoists* (power or hand) Drum hoists Platform elevators (portable)	Monorail trolleys* (hand) Traveling cranes (hand)

motor was 78 hp. and the actual power used in handling was 70 hp.

Systems are built for handling as much as 250 tons per hour when handling heavy, granular materials. For light, dusty materials the limit is about 50 tons per hour. Handling 10 tons per hour a distance of 150 ft., the cost for power and labor ordinarily will be in the neighborhood of $0.10 per ton.

Dragline-Scraper Conveyors

The capacity of dragline-scraper equipment depends on the rating of the scraper and the length of the haul. Tables XXX, XXXI, and XXXII show the capacity, costs and other data for one design of this type.

Hand-Operated Chain Hoists

There are three types of hand-operated chain hoist, the differential, the screw-geared, and the spur-geared. Of these types the differential has an efficiency of 30 per cent, the screw-geared has an efficiency of 40 per cent, while the spur-geared has an efficiency of 80 per cent. Tables XXXIII, XXXIV, and XXXV give data as to capacity, lift and list price for the three types of hoist.

These hoists are frequently supported by means of a trolley running on an I-beam. Trolleys are of various types, of which perhaps the most common is the steel plate trolley, data for which are given in Table XXXVI.

Table XIV—Tripper Horsepower and Constants for Belt Conveyor Horsepower

Width of Belt, In.	Value of K Plain Brgs.	Value of K Anti-Frict. Brgs.	Hp. for Tripper, P Plain Brgs.	Hp. for Tripper, P Anti-Frict. Brgs.
12	0.149	0.070	0.75	0.50
14	0.144	0.070	1.00	0.75
16	0.140	0.070	1.00	0.75
18	0.135	0.069	1.50	1.25
20	0.132	0.066	1.50	1.25
24	0.125	0.062	1.75	1.25
30	0.117	0.057	2.50	1.75
36	0.109	0.054	3.00	2.50
42	0.102	0.051	4.00	3.00
48	0.097	0.048	5.00	3.25
54	0.092	0.047	6.00	5.00
60	0.090	0.045	7.00	6.00

(Link-Belt Company)

Table XIII—Belt Conveyors; Capacities, Speeds, and Sizes of Pieces

Width of Belt, In.	Belt Ply Min.	Belt Ply Max.	Cross-Section of Load, Sq.Ft.	Cu.Ft. per Hour at 100 Ft. per Min.	Capacities in Tons per Hour at 100 Ft. per Min, at Weight per Cu.Ft. of Material of 50 Lb.	75 Lb.	100 Lb.	150 Lb.	Maximum Advisable Belt Speed, Ft. per Min.	Medium Size of Material, In. 80 Per Cent Under	20 Per Cent Not Over
12	3	4	0.084	504	12.6	18.9	25.2	37.8	300	1½	2
14	3	5	0.114	686	17.1	25.6	34.3	51.3	300	2	3
16	3	5	0.149	896	22.4	33.6	44.8	67.2	300	2½	4
18	4	6	0.189	1,134	28.3	42.5	56.7	84.9	350	3	5
20	4	6	0.233	1,400	35.0	52.5	70.0	105.0	350	3½	6
24	4	6	0.336	2,016	50.4	75.6	100.8	151.2	400	4½	8
30	5	7	0.525	3,150	78.7	118.1	157.5	236.2	500	7	12
36	6	8	0.751	4,536	113.4	170.1	226.8	340.2	600	8	16
42	6	9	1.029	6,174	154.3	231.5	308.7	463.0	600	10	20
48	6	10	1.333	8,064	201.6	302.4	402.2	604.8	600	12	24
54	8	11	1.701	10,206	255.1	382.6	510.2	765.3	600	13	26
60	8	12	2.100	12,600	315.0	472.5	630.0	945.0	600	14	28

(Link-Belt Company)

Table XVI—List Prices and Average Weights in Pounds for Belt Conveyor Idlers

Width of Belt, In.	Unit Troughing Idler Price Per Unit	Unit Troughing Idler Weight Per Unit, Lb.	Unit Troughing Idler With 5-in. Diam. Return Idler Price	With 5-in. Diam. Return Idler Weight, Lb.	Unit Troughing Idler With 6-in. Diam. Return Idle Price	With 6-in. Diam. Return Idle Weight, Lb.
14	$34.60	85	$45.80	118	$46.40	122
16	35.00	89	46.60	125	47.20	128
18	35.40	93	47.40	131	48.20	135
20	35.80	99	48.20	137	49.20	152
24	36.60	107	49.80	149	51.20	154
30	39.00	127	53.60	179	55.40	186
36	42.00	138	58.00	195	60.20	203
42	45.00	159	62.40	215	65.00	223
48	48.00	164	66.80	237	69.80	245
54	51.00	169	71.20	259	74.60	267
60	54.00	174	75.60	261	79.40	289

(Link-Belt Company)

Note: Above weights and prices are based on using standard 9 inch pedestal. When 15 inch is used, add 8 lbs. to weight, and $2.00 to list price.

Table XVII—Spacing in Feet of Carrying Idlers for Belt Conveyors

Width of Belt, In.	Weight of Material in Lb. per Cu.Ft. 35 and Under	40–70	75–100	125–150
12 & 14	5½	5	5	4½
16	5½	5	5	4½
18	5	4½	4½	4
20	5	4½	4½	4
24	5	4½	4	4
30	5	4½	4	3½
36	4½	4	3½	3
42	4½	4	3½	3
48	4	3½	3½	3½
54	4	3½	3½	3
60	4	3½	3½	3

(Link-Belt Company)

Spacing of Return Idlers

12 to 30-in belt..... 10-foot centers.
36 to 48-in. belt..... 9-foot centers.

Motor-Driven Chain Hoists

Chain hoists are equipped with electric motors for easy, quicker handling of loads. Table XXXVII gives data for one of the simpler types of this hoist. Speeds for

Table XVIII—Specifications and Dimensions for Bucket Elevators up to 80-Ft. Centers

Centrifugal Discharge, Malleable Iron Buckets, Single Strand Chain, Steel Casing

Size of Buckets, In.	Spacing of Buckets, In.	Diameter of Head Sprocket, In.	R.P.M. of Head Shaft	Speed of Buckets, Ft. per Min.	Hp. at Counter-Shaft	Capacity, Tons per Hour
6x4	13	16	48	207	1.2	6.7
7x4½	13	16	48	207	2.0	10.1
8x5	16	20	42	220	2.8	12.3
10x6	16	20	42	220	3.1	21.9
11x6	16	20	42	220	3.4	23.9
12x6	18	24	40	250	4.9	26.5
12x7	18	24	40	250	5.5	35.9
14x7	18	24	40	250	6.5	42.2
14x8	18	24	40	250	8.0	55.0

(Palmer-Bee Company)

Table XV—Approx. Weights of 28 Oz. Duck Rubber Conveyor Belt
Lb. per Ft.

Ply of Belt	Thickness of Top Cover Inches	Width of Belt, In. 12	14	16	18	20	24	30	60
3	¼	1.27	1.48	1.69	.....	.....	.....	.....	.....
	⅜	1.51	1.76	2.01	.....	.....	.....	.....	.....
	½	1.99	2.32	2.65	.....	.....	.....	.....	.....
	⅝	2.46	2.88	3.28	.....	.....	.....	.....	.....
4	¼	1.55	1.78	2.05	2.33	2.56	3.08	.....	.....
	⅜	1.78	2.08	2.37	2.67	2.96	3.56	.....	.....
	½	2.27	2.64	3.01	3.39	3.77	4.53	.....	.....
	⅝	2.75	3.19	3.64	4.09	4.54	5.46	.....	.....
5	¼	.....	.....	2.41	2.71	2.99	3.61	4.49	.....
	⅜	.....	.....	2.71	3.05	3.41	4.07	5.09	.....
	½	.....	.....	3.36	3.78	4.20	5.04	6.30	.....
	⅝	.....	.....	4.00	4.50	5.00	6.00	7.50	.....

Ply of Belt	Thickness of Top Cover Inches	Width of Belt, In. 20	24	30	36	42	48	54	60
6	¼	3.44	4.13	5.06	6.19	7.22	8.42	.....	.....
	⅜	3.84	4.61	5.76	6.92	8.06	9.4	.....	.....
	½	4.64	5.57	6.96	8.35	9.75	11.4	.....	.....
	⅝	5.44	6.54	8.16	9.80	11.42	13.35	.....	.....
7	¼	.....	.....	5.85	7.02	8.20	9.36	10.52	.....
	⅜	.....	.....	6.46	7.75	9.04	10.32	11.60	.....
	½	.....	.....	7.66	9.18	10.80	12.23	13.76	.....
	⅝	.....	.....	8.86	10.62	12.38	14.15	15.92	.....
8	¼	.....	.....	.....	7.82	9.14	10.40	11.70	13.00
	⅜	.....	.....	.....	8.55	9.96	11.38	12.78	14.22
	½	.....	.....	.....	9.97	11.63	13.30	14.95	16.62
	⅝	.....	.....	.....	11.40	13.31	15.21	17.12	19.00
9	¼	.....	.....	.....	.....	10.08	11.52	12.96	14.40
	⅜	.....	.....	.....	.....	10.92	12.48	14.03	15.63
	½	.....	.....	.....	.....	12.60	14.40	16.20	18.00
	⅝	.....	.....	.....	.....	14.28	16.32	18.36	20.40
10	¼	.....	.....	.....	.....	.....	12.65	14.15	15.80
	⅜	.....	.....	.....	.....	.....	13.60	15.30	17.16
	½	.....	.....	.....	.....	.....	15.56	17.50	19.40
	⅝	.....	.....	.....	.....	.....	17.50	19.65	22.00

(Link-Belt Company)

Note: The weight of 32-oz. duck, rubber-covered conveyor belt is 1/7 heavier than above weights.

motor-driven hoists are given in Table XXXVIII for both direct and alternating current.

Drum Hoists

There are several designs of drum hoist of varying complication and cost. That for which data are given in Table XXXIX is a simple type of friction hoist equipped with pulley for drive from a motor or other power source. It is supplied in both single- and double-friction designs.

Monorail Hoisting and Conveying Systems

Monorails are of two general types, the hand-operated and the motor-operated. The hand-operated type is made up of a chain hoist, a carrier for the hoist, and the supporting track or rail. Rail of this type, in lengths of 21 ft., lists at $0.65 per foot. Table XL gives data as to capacities, lifts, and list prices for this type. It covers only the simple design of hand-operated monorail. Many different special carriers, hoists and attachments are available for specialized services.

Hand-propelled monorails with electrically-operated hoists are available in many sizes. Table XLI gives data for a standard design of this type. Special designs are available.

Electrically propelled, motor-driven monorails are operated from the floor or by an operator seated in the carrier. Data for the floor-operated type are given in Table XLII. Data for the type operated from a cab are given in Table XLIII.

Traveling Cranes

Traveling cranes are of two general types, motor-operated and hand-operated. The hand-operated type is supplied in many sizes by different makers. Data for one manufacturer's hand-operated cranes are given in Table XLIV. As all cranes are more or less specially built, list prices are not available.

Light-weight, high-speed, motor-operated cranes are operated from the floor, as are the hand-operated type. Table XLV gives data for these cranes.

Heavy-duty traveling cranes of the motor-operated type can be obtained to suit almost any requirement. Manufacturers of such equipment should be consulted for data for each specific application.

Table XIX—Data for Steel Roller Chain

Pitch, In.	Approx. Weight per Ft., Lb.	Working Strength* in Lb. at 150 Ft. per Min.	Maximum Speed, Ft. per Min.	Average Ultimate Strength Lb.	List Price per Ft., Dollars
1.50	3.10	2,100	890	14,000	2.65
1.50	3.30	1,400	700	10,000	2.00
1.63	3.25	1,400	800	13,000	2.00
1.65	3.00	1,400	700	10,000	1.85
2.00	4.25	1,900	700	13,000	2.50
4.00	12.38	3,700	500	30,700	3.40
6.00	9.25	3,750	450	30,700	2.60
6.00	13.50	5,200	400	50,000	3.00
6.00	13.50	9,250	400	76,300	....
9.00	7.70	3,900	350	23,400	2.20
9.00	13.00	4,500	350	44,000	3.00
9.00	14.50	5,200	300	47,000	3.40
9.00	16.00	8,000	315	60,000	3.60
9.00	16.00	8,000	315	60,000	3.55
12.00	12.20	5,200	300	47,000	2.80
12.00	11.92	5,200	300	47,000	2.70
12.00	11.25	5,200	300	47,000	2.40
12.00	14.20	6,500	200	60,000	3.25
12.00	14.00	6,500	200	60,000	3.10
12.00	14.00	6,500	200	60,000	2.80
12.00	16.75	9,700	200	78,500	4.00
12.00	23.65	9,700	200	78,500	4.60

(Jeffrey Mfg. Company)

Table XX—Data for Chain Trolleys

Chain: Average Pitch, In.	Chain: Average Ultimate Strength,* Lb.	Chain: Maximum Working Load, Lb.	Chain: Weight Plain, per Ft., Lb.	Trolley: Wheel Diam., In.	Trolley: Maximum Capacity, Lb.*	Trolley: Weight, Lb.
2.609	14,000	2,000	3.5	2½	100	5¼
2.609	14,000	2,000	3.5	3½	500	7
3.075	24,000	3,200	6.7	3½	500	8
4.031	30,000	3,000	3.0	3½	500	7
6.031	60,000	6,000	6.2	3½	500	7

*Based on a maximum trolley speed of 50 ft. per min.

(Chain Belt Company)

Table XXII—Capacities of Slat or Platform Conveyors
Different Chain Strengths for Each Conveyor Width

Conveyor Width, Inches*	Capacity Tons per Hour†	Max. Weight Package, Pounds	Min. Package Spacing, Feet	Conveyor Load per Foot, Pounds
18	45	150	6	25
	67½	150	4	37
	90	150	3	50
	90	200	4	50
24	60	150	4.6	33
	90	150	3	50
	120	150	2.3	65
	135	200	2.6	75
	135	600	8	100
30	75	200	5	40
	112½	200	3.2	62
	150	200	2.4	83
	180	250	2.5	100
	180	600	6	100
36	90	200	4	50
	135	200	2.6	75
	180	200	2	100
	225	250	2	125
	225	600	4.8	125
	252	600	4.3	140
	270	900	6	150
48	270	500	3.3	150
	324	500	2.8	180
	360	700	3.5	200

(Chain Belt Company)

*Conveyor width equals length of conveyor slats.
†Capacity per hour based on a speed of 60 ft. per min.

Table XXIII—Data for Pivoted Bucket Carriers
Using Standard Long-Pitch Steel-Bushed Roller Chain

Size of Bucket, In.	Pitch, In.	Capacity, in Tons per Hour: Coal, 50 Lb. per Cu. Ft.	Capacity, in Tons per Hour: *Stone, 100 Lb. per Cu. Ft.	Speed, Ft. per Min.	†Weight of Chain and Bucket, per Ft., Lb.
18x15	18	15– 20	30– 40	30–40	97
18x21	18	22– 30	44– 60	30–40	103
24x18	24	40– 50	80–100	40–50	96
24x24	24	50– 62	100–124	40–50	106
24x30	24	70– 87	140–174	40–50	126
24x36	24	90–112	180–224	40–50	136
30x24	30	78– 96	156–192	45–55	166
30x30	30	100–125	200–250	45–55	176
30x36	30	125–150	250–300	45–55	211
36x36	36	175–210	350–420	50–60	249

(Stephens-Adamson Mfg. Company)

*Based on material 1½ in. and under in size.
Standard long pitch steel bushed roller chain used.
†Heavier chain also available for each size.

Table XXI—Capacity of Apron and Pan Conveyors in Cubic Feet per Hour

Actual Width of Carrying Surface, In.	Height of Sides (Inches) 2	3	4	5	6	7	8	10	12	14	16	18	20	24	30
18	112	168	225	281	337	393	450	562	675	787	900	1012	1125	1350	1688
24	150	225	300	375	450	525	600	750	900	1050	1200	1350	1500	1800	2250
30	187	281	375	468	562	656	750	937	1125	1312	1500	1687	1875	2250	2813
36	225	337	450	562	675	787	900	1125	1350	1575	1800	2025	2250	2700	3375
42	262	393	525	656	787	918	1050	1312	1575	1837	2100	2362	2625	3150	3937
48	300	450	600	750	900	1050	1200	1500	1800	2100	2400	2700	3000	3600	4500
54	337	506	675	843	1012	1181	1350	1688	2025	2362	2700	3037	3375	4050	5063
60	375	562	750	937	1125	1312	1500	1875	2250	2625	3000	3375	3750	4500	5625

(Link-Belt Company)

Table XXIV—Data and List Prices for Standard V-Bucket Carriers

Data: Average Size Material, In.	Data: Maximum Size Pieces, In.	Data: Capacity Tons per Hour (Coal)	Data: Bucket Size, In. (Length x Width x Depth)	Data: Hp. for Maximum Centers	List Prices, Dollars: Terminals: Complete *	Terminals: Less, if Drive Frame Omitted	Terminals: Less, if Head Housing Omitted	Per Foot Centers: Vertical Run Complete †	Per Foot Centers: Less, if Casing and Guide Angles Omitted	Per Foot Centers: Horizontal Run Complete ‡	Per Foot Centers: Less, if Steel Conveyor Frame Omitted	Valve With Standard Bifurcated Chute, Each
3½	7	28	18x14x 7	7	1,300	230	296	29.85	17.40	24.45	7.50	120
4	8	42	20x16x 8	9	1,380	233	298	31.65	18.00	26.40	7.70	120
4	8	31	20x16x 8	8½	1,405	230	306	29.15	18.00	23.35	7.15	120
4	8	28	20x16x 8	6½	1,490	230	318	34.20	18.00	28.55	7.30	120
4½	9	47	24x18x 9	11	1,780	246	336	35.85	20.70	28.85	8.25	158
4½	9	41	24x18x 9	9	1,880	244	348	38.50	20.70	31.15	7.90	158
5	10	63	26x20x10	13½	1,825	249	329	37.40	21.25	30.40	8.25	158
5	10	56	26x20x10	11½	1,885	249	329	41.65	21.25	34.10	8.25	158
6	12	92	30x24x12	17½	2,480	261	359	48.50	24.30	39.51	8.65	167

*Terminal complete includes boot, upper corner section with its housing, curved trough corner section and drive frame, shafts, bearings, sprockets, gears, etc., to and including second countershaft.

†Vertical run complete includes chain and buckets and guide angle with steel casing.

‡Horizontal run complete includes chain, buckets, trough and steel conveyor frame for spans not greater than 12 ft. Supports for conveyor frames are extra.

(Jeffrey Mfg. Company)

Table XXV—Data for Scraper or Flight Conveyors

Flight Size Width x Length, In.	Capacities in Tons of Coal per Hour, Speed 100 Ft. per Min.: Horizontal Conveyor—Flight Spacing, In.: 16	18	24	Lb. Moved per Flight	Inclined Conveyor Flights Spaced 24 In.: 10 Deg.	20 Deg.	30 Deg.
4x10	33.75	30	22.5	15	18.0	14.5	10.5
4x12	42.75	38	28.5	19	24.0	18.0	13.5
5x12	51.75	46	34.5	23	28.5	22.5	16.5
5x15	69.75	62	46.5	31	40.5	31.5	22.5
6x18	.....	80	60.0	40	49.5	40.5	31.5
8x18	.....	120	90.0	60	72.0	57.0	48.0
8x20	.....	...	105.0	70	84.0	66.5	56.0
8x24	.....	...	135.0	90	120.0	96.0	72.0
10x24	.....	...	172.5	115	150.0	120.0	90.0

(Chain Belt Company)

Table XXVI—Data for Drag Chain Conveyors

Capacity in Cu.Ft. per Hour* Speed, Ft. per Min.		Pitch Diameter 8-Tooth Head Sprocket, Inches	R.P.M. of Head Shaft 30 Ft. per Min.	40 Ft per Min.
30	40			
400	533	15.68	7.5	10.0
600	800	15.68	7.5	10.0
800	1,067	20.90	5.63	7.5

(Chain Belt Company)

*Depth of material conveyed depends on whether material is fine or lumpy. Above capacities are based on a 4-in. depth, which is conservative for fine material. Speeds for abrasive material should not exceed 30 ft. per minute. For speeds other than those stated, capacities will be in direct proportion.

Table XXVII—Sizes, Capacities and Speeds of Screw Conveyors

Diameter in In.: Conveyor	Pipe, Inside	Coupling	Std. Lgth., Ft.*	Bearing Lgth., In.	Size Material In.†: Maximum Uniform Size	Maximum Unsized	Light, Non-Abrasive Material As Grain: Thickness Flights, Gage or In.	Max. Speed, R.P.M.	Capacity‡ per Hour Cu. Ft.	Heavy, Non-Abrasive Material As Coal: Thickness Flights, Gage or In.	Max. Speed, R.P.M.	Capacity‡ per Hour Cu.Ft.	Heavy, Abrasive Material, as Sand and Ashes: Thickness, Flights, In.	Max. Speed, R.P.M.	Capacity, per Hr., Cu.Ft.‡
4	1	1	8	1½	¼	1	18	200	105	10	110	55	⅛	85	45
6	1½	1½	10	2	⅜	1½	16	180	315	10	100	175	⅛	75	130
9	1½	1½	10	2	⅜	2½	14	175	1,100	10	95	600	⅛	70	440
9	2	2	10	2	⅜	2½	14	175	1,100	10	95	600	¼	70	440
10	1½	1½	10	2	⅜	2½	14	160	1,400	..	...	....	..	..	....
10	2	2	10	2	⅜	2½	14	160	1,400	..	...	....	..	..	....
12	2	2	12	2	1	3	12	150	2,260	7/16	85	1,280	¼	65	980
12	2½	2 7/16	12	3	1	3	12	150	2,260	..	...	....	..	..	....
12	3	3	12	3	1	3	12	150	2,260	7/16	85	1,280	¼	65	980
14	2½	2 7/16	12	3	1¼	3½	12	150	3,600	7/16	80	1,930	⅜	60	1,450
14	3	3	12	3	1¼	3½	10	150	3,600	7/16	80	1,930	⅜	60	1,450
16	3	3	12	3	1½	4	10	150	5,400	½	75	2,700	⅜	55	2,000
18	3	3	12	3	1½	4½	10	130	6,600	½	65	3,300	⅜	50	2,550
20	3½	3	12	3	1½	5	7/16	115	7,900	½	60	4,100	..	..	....
20	4	3 7/16	12	4	1½	5	..	....	....	½	60	4,100	¼	45	3,100
24	4	3 7/16	12	4	2	6	¼	100	12,100	½	50	6,050	¼	40	4,800

(Chain Belt Company)

*Standard length of conveyor section, measured from center to center of bearings; actual length of flights equals standard length minus bearing length.

†Approximately 90 per cent of material to be of "Max. Uniform size" stated; not more than 10 per cent of unsized material to be of "Max. Unsized" stated.

‡Capacities stated are at maximum r.p.m. with uniform and continuous flow of material, based on cross-sectional area of material in box equal to about ¼ of the area of the screw. Capacities at other speeds are in direct proportion to those listed.

Size of the material handled should never exceed ¼ of the diameter of the screw.

The above data on speeds and capacities represent good practice, but may be departed from, depending on conditions. It is recommended that the maximum speeds shown be not exceeded.

Hand-Operated Lift Trucks

Hand-operated lift trucks are available in a great variety of sizes and capacities. Table XLVI gives information that may be used in estimating for this type of equipment.

Skid Platforms

The U. S. Department of Commerce, in co-operation with manufacturers and users, has standardized on 7-in. and 11-in. heights for lowered skid platforms. Two sizes have been selected as meeting general requirements. The smaller measures 33x54 in. and can be loaded to 4,000 lb. if the height of the load is not too great. The larger measures 42x66 in. and is recommended for bulky material. The smaller skid can be loaded three abreast in standard box cars, while the larger can be loaded two abreast. Skid platforms are listed at from $3.50 to $15 each, depending upon size, capacity, and type.

Table XXVIII—List Prices of Standard Screw Conveyor Flights*

Diameter—Inches: Conveyor	Pipe	Inside Couplings	List Price in Dollars Per Foot of Standard Black Conveyor On Heavy Pipe Core—Thickness Steel Flights, Gage or Inches: No. 10	7/16	¼	⅛	⅜	On Std. Pipe Core: Std. Wt.
4	1	1	3.00	3.25	3.75	....	....	2.75
6	1½	1½	3.25	4.00	5.00	8.00	....	3.00
9	1½	1½	4.25	5.00	5.75	....	....	4.00
9	2	2	5.00	5.75	6.50	8.50	....	4.50
12	2	2	....	6.25	7.00	....	....	4.50
12	3	3	....	7.50	8.25	11.00	....	5.00
12	3½	3	....	....	....	....	16.00	5.00
14	2½	2 7/16	....	8.00	9.00	....	....	6.00
14	3	3	....	9.00	10.00	13.00	....	7.00
14	4	3	....	....	....	....	18.00	7.50
16	3	3	....	9.50	10.50	14.00	....	8.50
16	4	3	....	....	....	....	20.00	9.00
18	3	3	....	12.00	14.00	19.00	....	11.00
18	4	3	....	....	....	....	25.00	....
20	3½	3	....	17.00	19.00	....	....	....
20	4	3 7/16	....	....	....	25.00	30.00	....
24	4	3 7/16	....	23.00	25.00	35.00	45.00	....

*Standard lengths same as Table XXVII.

(Chain Belt Company)

Table XXIX—List Prices of Screw Conveyor Accessories

	Price Range, Dollars
Cast-iron box ends for wooden boxes	$2.00 to $17.00
Cast-iron box ends for steel boxes	2.00 to 17.00
Discharge box ends	1.75 to 18.00
Countershaft box ends, wooden boxes	21.00 to 126.00
Countershaft box ends, steel boxes	21.00 to 126.00
Right-angle drives	38.00 to 205.00
Hanger bearings	2.00 to 20.00
Steel linings for wooden boxes, per foot	0.25 to 7.00
Steel troughs with covers, per ft.	3.50 to 30.00
Flanges	1.75 to 13.00
Saddles	1.25 to 8.00
Gates and spouts (depending on design)	1.50 to 110.00

Portable Platform Elevators

Hand-operated and motor-operated portable platform elevators are used for raising and lowering loads. For loads not exceeding 500 lb., elevating up to 10 ft. in height, a gearless hand-operated machine is available at a list

Table XXX—Handling Capacities of Dragline Scrapers

Estimated Hourly Capacities in Cubic Yards for Different Sizes of Scrapers Operating on Various Lengths of Haul

Length of Haul, Ft.	Size of Scraper, Cubic Yards										
	¼	½	¾	1	1½	2	2½	3	4	5	6
100	22	34	51	80	120	160	200	240	320	400	480
200	12	18	27	42	63	84	105	127	168	210	254
300	8	12	19	28	42	56	70	84	112	140	168
400	6	10	14	21	32	43	53	63	86	106	126
500	5	7	11	17	26	34	43	52	68	86	104

(Sauerman Bros., Inc.)

The above handling capacities are based upon line speeds attained in average material. Actual capacities will vary from this table by amounts depending entirely upon local conditions.

Table XXXI—Dragline Scraper, Storing and Reclaiming Coal

Size of Scraper Bucket, Cu.Yd.	Average Haul, Ft.	Capacity, Tons per Hour	Operating Cost per Ton (Approx.) Dollars	Cost of Machine (Approx.) Dollars	Hp. of Motor
¼	200	18	0.045	2,500 to 4,000	15
3	200	100	0.040	11,000 to 16,000	100
4½	200	170	0.035	13,000 to 18,000	125
7	200	265	0.030	20,000 to 30,000	200
10	200	365	0.028	26,000 to 40,000	300

(Sauerman Bros., Inc.)

These machines are made in 15 sizes from ¼ cu.yd. to 12 cu.yd. capacity. They operate between head and back posts, or between movable steel towers, and for spans up to 600 or 700 ft. The costs given are for certain representative machines, and cover both storing and reclaiming. Operating costs vary with distance material is moved, continuity of operation, etc. The first cost varies widely because of the great difference in the layouts of different storage yards.

Table XXXII—Dragline Scraper, Storing and Reclaiming Crushed Stone

Size of Scraper Bucket, Cu.Yd.	Average Haul, Ft.	Capacity, Tons per Hour	Operating Cost per Ton (Approx.) Dollars	Cost of Machine (Approx.) Dollars	Hp. of Motor
½	100	50	0.06	5,000	20
1½	200	90	0.08	10,000	75
3	300	150	0.09	20,000*	125
5	400	275	0.095	30,000*	200

(Sauerman Bros., Inc.)

These machines are made with 12 different sizes of buckets, ranging from ½ cu.yd. to 8 cu.yd. capacity, operating between masts, or between steel towers, and for spans up to about 600 ft. Costs are for representative installations. Costs vary with distance material is moved, layout, continuity of operation, etc.

*Machines of 3 cu.yd. size and larger usually have a movable steel head-tower and the above cost is figured accordingly.

price of about $200. Higher-priced, geared, hand-operated elevators, made for elevating up to 20 ft., are also available.

Combination hand-operated and motor-operated elevators in sizes of 500 lb. and up to 40 ft., 750 lb. and up to 27 ft., 1,000 lb. and up to 20 ft., 1,500 lb. and up to 13 ft., and 2,000 lb. and up to 10 ft., are available.

Fully electrically operated, portable platform elevators are available in sizes as shown in Table XLVII.

Data supplied by the Lewis-Shepard Company indicate that list prices for portable platform elevators range from slightly less than $200 to $1,750 for an elevator of 4 tons capacity.

Permanently Installed Freight or Platform Elevators

For elevators of this type, permanently installed in buildings for the handling of all types of loads, specifications and prices should be obtained from a manufacturer, by supplying him with all necessary data.

Electric Trucks

Many types and capacities of electric trucks are available. The 2-ton model, however, is much used where standard types are suitable. Table XLVIII gives information as to capacities and prices.

Speeds of electric industrial trucks when loaded are from 4 to 6 miles per hour, and when unloaded, about 50 per cent greater. These figures are for operation on level concrete. On grades, speeds are somewhat less, as also on rough surfaces. Larger model trucks, suitable for use in warehouses, wharfs, and terminals, have load capacity from 50 to 100 per cent over those in the table and operate at speeds from 7 to 10 miles per hour.

Skid platforms used with these trucks are similar to those used with hand-operated lift trucks.

Tractors and Trailers

According to the Mercury Manufacturing Company, the average cost of an electric industrial tractor with battery is about $2,500; the average cost of a gas-engine industrial tractor is about $1,350; and the average cost of a trailer is $60. It is usual practice to employ 50 trailers for each tractor. Table XLIX gives data as to capacities and list prices of tractors. Ball-bearing platform trailers, 72x36 in., and 16½ in. high, weigh 500 lb. and have a capacity of 2 tons load.

Table XXXIII—Capacity, Lift and List Prices of Differential Chain Hoists

Capacity, Tons	Price Complete, Dollars	Standard Lift,* Ft.	Extra Lift, Price per Ft.† Dollars
½	36	6	4.80
¾	42	7	4.80
1	56	8	5.00
1½	72	8½	5.40
2	90	9	5.60

(Yale & Towne Mfg. Company)

* "Standard lift" means hook travel.
† Each foot of extra hoist includes 4 ft. of chain.

Table XXXIV—Capacity, Lift and List Prices of Screw-Geared Chain Hoists

Capacity, Tons	Price Complete, Dollars	Standard Lift, Ft.	Extra Lift, Price per Ft., Dollars
½	50	8	2.50
1	60	8	2.60
1½	80	8	2.70
2	100	9	2.80
3	150	10	3.00
4	190	10	3.80

(Yale & Towne Mfg. Company)

Table XXXV—Capacity, Lift and List Prices of Ball-Bearing, Spur-Geared Chain Hoists

Rated Capacity, Long Tons	Price Complete, Dollars	Standard Lift, Ft.	Extra Lift, Price per Ft., Dollars
½	70	8	1.80
¾	70	8	1.80
1	90	8	1.90
1½	120	8	2.00
2	140	9	2.10
3	180	10	3.00
4	220	10	3.20
5	280	12	4.30
6	330	12	4.30
8	400	12	5.40
10	480	12	6.50
12	600	12	8.60
16	720	12	10.80
20	850	12	13.00

(Yale & Towne Mfg. Company)

Table XXXVI—Data for Steel-Plate Trolleys

Capacity, Tons	Standard Size of I-Beam,† In.	Greatest Distance Between Supports, Ft.	Diameter of Tread Wheels, In.	Price Plain Trolley, Dollars
½	4	10	3	22
¾*	5	14	3½	25
1	6	14	4½	29
1½	7	15	5½	39
2	8	16	6½	46
3	9	16	7½	61
4	10	16	8½	85
5	12	18	10	109
6	15	21	10	134
8	20	28	12	170
10	24	32	13	218
12	24	29	13	295
15	24	26	18	485
20	24	21	18	585

(Yale & Towne Mfg. Company)

* ½ ton and larger are equipped with roller bearings.
† Adjustable without extra cost for I-beams three sizes larger than standard. Also adjustable for I-beams of non-standard slant.

Industrial Railways

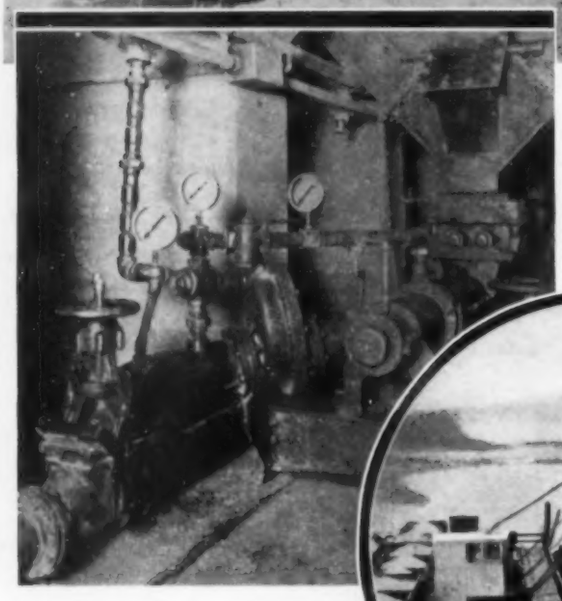
Equipment of the industrial-railway type is made in a variety to suit every purpose. As installations of this equipment always are special and of considerable magnitude, a manufacturer should be consulted before any attempt is made to estimate costs.

Cost of Handling Materials

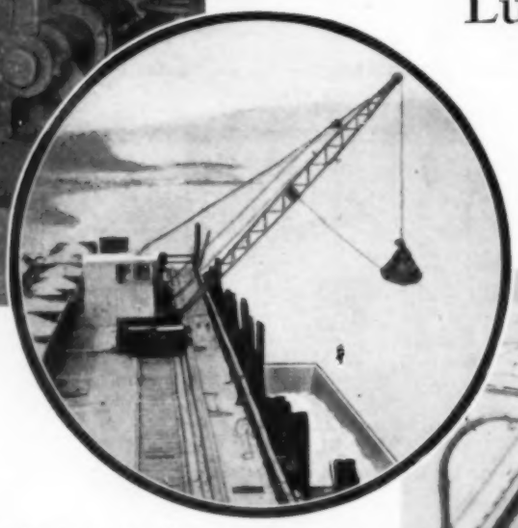
Reliable data from operating experience for estimating the cost of operation of handling equipment by conveyors, overhead equipment or industrial railways is not available. This is due to the fact that no two installations are at all alike in results obtained. All the conditions affect-

ABOVE: Gantry or bridge cranes are much used for handling large quantities of raw materials to outdoor storage from ships or cars.

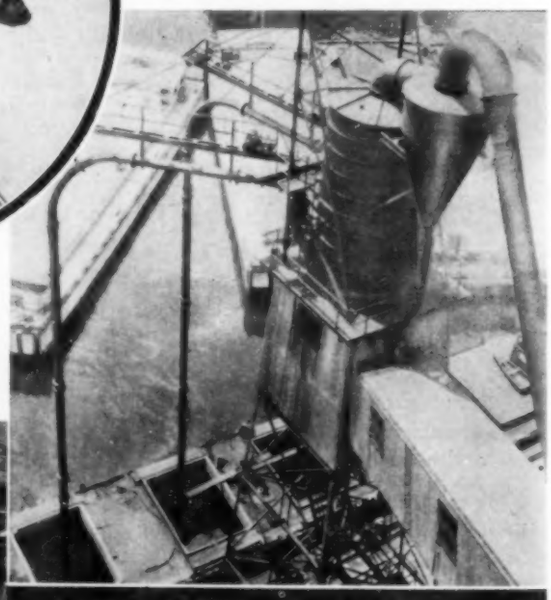
BULK HANDLING for Lump or Pulverized Materials



ABOVE: This cement plant is using a Fuller-Kinyon solids pump for unloading finished cement from silos. The pump is portable, running on tracks where temporary connections may be made to any silo and to the air and discharge lines.



LEFT: Locomotive cranes are used by the Aluminum Ore Company to transfer bauxite from cars to barges. This type of equipment is a convenient link between cars and storage.



RIGHT: Bulk material being unloaded from boats at the rate of 200 tons per hour by means of a Holly pneumatic conveyor. The lift is 80 ft.

BELOW: Cleveland overhead traveling crane with 4-yard bucket, in a superphosphate plant of the Tennessee Copper & Chemical Company.

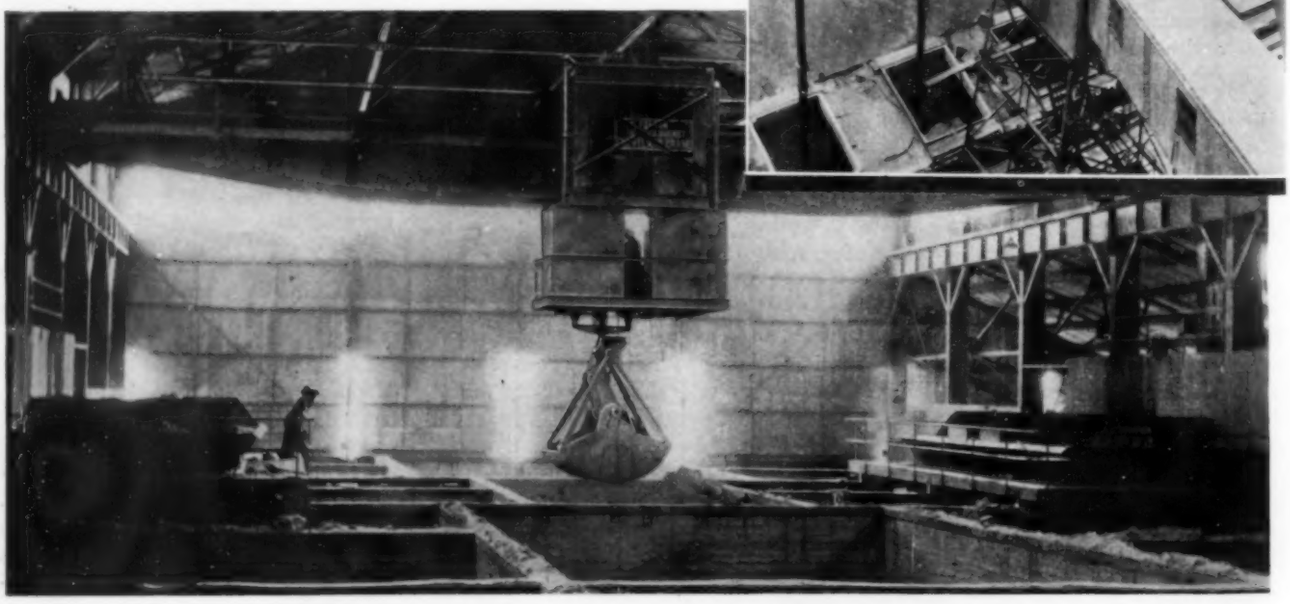


Table XXXVII—Data for Electric Motor-Driven Chain Hoists With Manual Control

Combination of Hoist With	List Price, Dollars: ½ Ton Quick Speed ½ Ton Standard Speed — Standard 10 Ft. Lift	Extra Lift per Ft.	½ Ton Quick Speed 1 Ton Standard Speed — Standard 10 Ft. Lift	Extra Lift per Ft.	2 Ton Standard Speed — Standard 10 Ft. Lift	Extra Lift per Ft.
Hook or clevis	310	0.92	417.50	1.05	519.00	1.85
Plain trolley	320	0.92	430.00	1.05	540.00	1.85
Plain trolley with current collectors	330	0.92	440.00	1.05	550.00	1.85
Geared trolley	342	1.62	448.75	1.75	561.50	2.55
Geared trolley with current collectors	352	1.62	458.75	1.75	571.50	2.55
Built-in trolley	330	0.92	440.00	1.05	550.00	1.85
Built-in trolley with current collectors	340	0.92	450.00	1.05	560.00	1.85

(Yale & Towne Mfg. Company)

ing cost vary in each installation. Distances moved, quantities handled, use factor of equipment, cost of power and cost of labor, among other factors, are of such a wide range as to prevent the determination of accurate unit costs.

Handling by trucks and tractors has been the subject of much study and fairly reliable unit costs for estimating purposes are available.

Hand-operated lift trucks, handling miscellaneous material about a warehouse, showed a handling cost of about $0.45 per ton on one job. These trucks and their accompanying quota of skid platforms have a yearly maintenance cost of from 0.5 to 2 per cent of the first cost. Many lift trucks of this type average about $1 per year for maintenance.

Portable platform-elevator maintenance averages about $15 per year. Cost of handling can be estimated from the power required over the period of operation and the labor expense.

Electric industrial trucks, according to the Industrial Truck Association, have yearly operating charges as shown in Table L. Handling costs for unloading 1,000,000 lb. of billets per day, and moving these 150 ft., are $0.02 per ton. For handling 48 rolls of paper per hour over 300 ft. and stacking four high, costs are 3⅓ cents per ton.

This same association also finds that the cost of operating these trucks, in average service, can be figured at $0.50 per hour.

The Baker-Raulang Company gives the following costs per day for operating a truck in average service: platform trucks, $2.50; lift trucks, $3 to $3.50; high-lift trucks, $3 to $3.50; fork trucks, $3.25; crane trucks, $4.25.

Tractors, according to the Baker-Raulang Company, cost $3 per day to operate. The Mercury Manufacturing Company gives the same figure,

Table XXXVIII—Speeds of Motor-Driven Chain Hoists With Direct and Alternating Current

Direct Current

Rated Capacity, Tons*	Speeds, Ft. per Min.: Hoisting — No Load	Hoisting — Half Load	Hoisting — Full Load	Lowering — No Load	Lowering — Full Load
¼ Q.S.	72	46	36	72	56
½	36	23	18	36	28
¼ Q.S.	60	40	32	60	45
1	40	25	20	40	30
1 Q.S.	54	34	29	54	38
2	20	12½	10	20	15
2 Q.S.	27	17	15	27	18

Alternating Current

Rated Capacity, in Tons*	Speeds, Ft. per Min.: Polyphase — Hoisting	Polyphase — Lowering	Single Phase — Hoisting — No Load	Hoisting — Full Load	Lowering — No Load	Lowering — Full Load
¼ Q.S.	32	34	72	40	72	66
½	16	17	36	20	36	33
¼ Q.S.	35	38	54	32	54	45
¼ H.S.	52	57	..	..	..	..
1 L.S.	6	7	..	..	..	..
1	18	19	36	17	36	28
1 Q.S.	26	29	..	..	..	..
2 L.S.	3	3½	..	..	..	..
2	9	9½	18	8½	18	14
2 Q.S.	13	14	..	..	..	..

(Yale & Towne Mfg. Company)

* Q.S. is used as abbreviation for Quick Speed, H.S. for High Speed; L.S. is used as abbreviation for Low Speed.

Table XLI—Data for Hand-Propelled, Motor Driven Monorails

Capacity Tons	Speed, Ft. per Min.	Max. Lift, Ft.	Motor Hp.	List Price, Dollars*
½	40–80	16–30	1	246 to 364
½	20–80	16–28	1½	273 to 476
1	20–80	17–30	3	368 to 620
2	20–56	18–30	5	503 to 764

*Depending on control and lift

(Cleveland Crane & Engineering Company)

Table XL—Data for Hand-Operated Monorails

Capacity, Tons	Standard Lift, Ft.	Shipping Weight, Lb.	List Price, Carrier Only	List Price, Hoist Only	Price per Extra Ft. of Lift
1/10	8	126	$20	$60	$1.80
¼	8	135	20	60	1.80
½	8	140	20	70	1.80
1	8	165	20	90	1.90
1½	8	295	55	120	2.00
2	9	300	55	140	2.10

(Cleveland Crane & Engineering Company)

Table XLIII—Electrically-Propelled, Motor-Driven Monorails Operated From Cab

Capacity, Tons	Standard Lift, Ft.	Lifting Speed, Ft. per Min.	Min. Hp. Motor	Size Rope, In.	List Price: 110–440 Volt 3 Phase 60 Cycle	List Price: 110–220 Volt Direct Current	Weight Lb.
1	16	20–25	2	5/16	$1,290.00	$1,210.00	2,180
1	30	20–25	2	⅜	1,290.00	1,210.00	2,180
2	15	15–20	3	⅜	1,305.00	1,225.00	2,200
3	13	10–15	3	5/16	1,505.00	1,415.00	2,200
3	20	10–15	3	⅜	1,720.00	1,640.00	3,720
3	36	10–15	3	5/16	1,720.00	1,640.00	3,720
5	18	10–15	5	5/16	1,830.00	1,830.00	3,760
5	28	15–20	7½	5/16	2,218.00	2,110.00	6,045
7½	24	10–15	7½	½	2,218.00	2,110.00	6,075
10	16	10–15	10	½	2,597.00	2,474.00	6,300
10	25	20–25	20	5/16	2,982.00	3,182.00	7,360
15	16	15–20	20	5/16	3,132.00	3,332.00	7,450

(Euclid Crane & Hoist Company)

Table XLIV—Hand-Operated Traveling Cranes

Capacity, Tons,	Span, Feet	Maximum Lift, Feet
5	20 to 50	32
10	20 to 50	32
15	20 to 50 or up	45
20	20 to 50 or up	45

(Whiting Corporation)

Table XLV—Data for Light-Weight, Motor-Operated Traveling Cranes

Capacity, Tons	Span, Feet	Capacity, Tons	Span, Feet
1	15 to 20	3	25 to 35
2	20 to 25	5	35 to 40

(Whiting Corporation)

Table XLVI—Data for Hand-Operated Lift Trucks

Type	Maximum Capacity Lb.	Minimum Lift, In.	No. of Strokes for Maximum Lift	List Price, (Depending on Size) Dollars
"Single lift"	2,500	1¾	1	60 to 130
"Jacklift"	2,600	1¾	4	113 to 435
"Jacklift"	5,000	1¾	7	
"Jacklift"	8,000	1¾	8	
"Jacklift"	10,000	1¾	8	

(Lewis-Shepard Company)

Table XXXIX—Data for Friction Drum Hoists

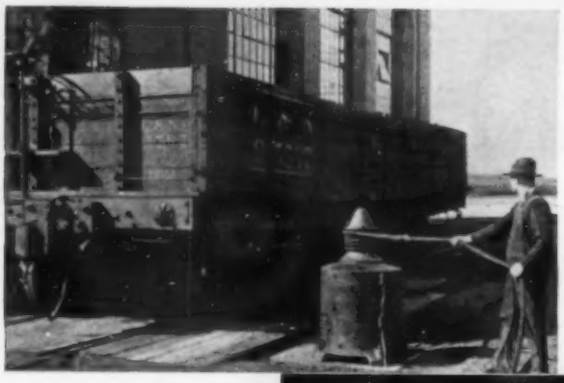
Size of Drum, In.	Rope Pull, Lb.	Speed, Ft. per Min.	Max. Size of Rope, In.	Drive Pulley: Diam. Flanges, In.	Drive Pulley: Diam., In.	Drive Pulley: Face, In.	R.P.M.	Weight, Lb.	List Price, Dollars
Single Friction									
12x19	1,300	150		18	30	6	200	1,300	300.00
12x24	1,300	150		18	30	6	200	1,400	322.50
18x18	2,000	300		24	36	8	300	2,600	435.00
18x24	2,000	300		24	36	8	300	2,800	465.00
20x24	2,000	300	⅜	26	36	8	270	3,000	495.00
24x24	2,300	300		30	36	8	250	3,600	600.00
24x24	3,000	300		30	36	10	300	4,300	705.00
24x30	3,000	300		30	36	10	300	4,700	750.00
Double Friction									
24x24	3,000	300		30	36	10	300	4,700	973.50
24x30	3,000	300		30	36	10	300	4,900	1,006.50
24x36	3,000	300		30	36	10	300	5,200	1,039.50
30x30	4,000	300		36	36	12	300	5,500	1,105.50
30x36	4,000	300		36	36	12	300	5,700	1,138.50
36x36	5,000	300		42	40	12	300	7,000	1,320.00
36x42	5,000	300		42	40	12	300	7,200	1,369.50

(Stephens-Adamson Mfg. Company)

Table XLII—Electrically-Propelled, Motor-Driven Monorails, Floor Operated

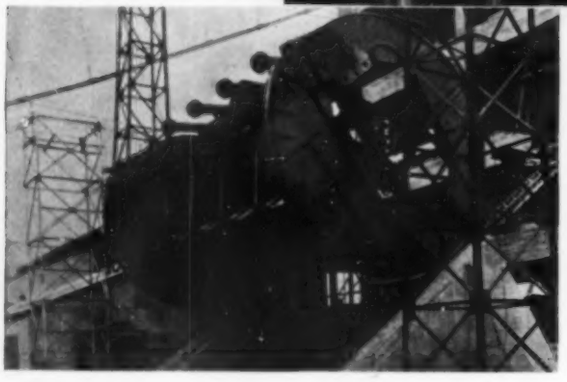
Capacity, Tons	Standard Lift, Ft.	Lifting Speed, Ft. per Min.	Min. Hp. Motor	Size Rope, In.	List Price: 110–440 Volt 3 Phase 60 Cycle	List Price: 110–220 Volt Direct Current	Weight Lb.
½	18	25–30	1½	5/16	$325.00	$338.00	515
½	40	25–30	1½	5/16	350.00	363.00	625
1	9	15–20	2	5/16	377.00	390.00	515
1	20	15–20	2	⅜	400.00	415.00	625
1	30	20–25	2	⅜	513.00	513.00	880
2	10	10–15	2	5/16	460.00	475.00	650
2	15	15–20	3	⅜	528.00	528.00	900
3	13	10–15	3	5/16	578.00	568.00	900
3	20	10–15	3	⅜	749.00	749.00	1,745
3	36	10–15	3	5/16	749.00	749.00	1,745
5	18	10–15	5	5/16	840.00	890.00	1,775
5	28	15–20	7½	5/16	1,098.00	1,040.00	3,140
7½	24	10–15	7½	½	1,098.00	1,040.00	3,140
10	16	10–15	10	½	1,235.00	1,189.00	3,300
10	25	20–25	20	5/16	1,585.00	1,732.00	5,000
15	16	15–20	20	5/16	1,735.00	1,882.00	5,100

(Euclid Crane & Hoist Company)



ELECTRIC capstans or car pullers do the job of spotting cars quicker and cheaper than can be done by hand with a pinch bar. This machine, of Stephens-Adamson manufacture, shows how such devices operate. One man keeps the rope taut as it is paid out by the puller, and moves the car without effort.

TRAVELING larries are much used as charging equipment. Most of them, as in the case of this Link-Belt machine, are motor-driven and equipped with scales. Their principal field is in coal-gas, water-gas and other coal-handling applications. This machine is charging coke in a water-gas plant.



MODERN plants avoid excessive handling costs and demurrage charges by the use of equipment for quick unloading of freight cars. Car tippers are the quickest for gondola cars. This G.E.-equipped rolling dumper rolls cars up an incline at the Tampa plant of the Florida Portland Cement Company, dumping the load into a hopper at the right.

Table XLVII—Data for Electric Portable Platform Elevators

Capacity, Lb.	Speed, Ft. per Min. ¾ Hp.	2 Hp.	3 Hp.	5 Hp.	Lifting Height, Max. Ft.
500	60	..	..	..	40
750	40	53	..	..	27
1,000	30	40	60	..	20
1,500	20	27	40	65	13
2,000	15	20	30	50	10
3,000	10	13	20	33	20
4,000	7½	10	15	25	20
5,000	6	8	10	20	20

(Barrett-Cravens Company)

Table XLVIII—Data for Electric Industrial Trucks

Model	Capacity, Lb.	List Price Less Battery, Dollars	List Price of Batteries, Dollars
Platform.	4,000- 6,000	1,700-2,000	400 to 1,000
Lift.....	4,000- 6,000	2,000-2,250	
Lift.....	10,000-20,000	2,800-3,500	
High-Lift	4,000- 6,000	2,250-2,750	
High-Lift	10,000-20,000	3,250-5,000	
Fork.....	3,000- 8,000	2,500-4,500	
Crane....	3,000- 6,000	3,750-4,200	

(Baker-Raulang Company)

Table XLIX—Data for Electric Industrial Tractors

Type	Capacity, Lb. Draw-Bar Pull	List Price Less Battery
4-wheel	....	....
2-wheel drive.....	2,000	$1,850
4-wheel drive.....	3,200	2,050
3-wheel.....	1,800	1,575

(Baker-Raulang Company)

Table L—Yearly Operating Charges for Electric Industrial Trucks

Depreciation of truck.....	$200.00
Depreciation of battery.....	100.00
Depreciation of charging equipment.....	15.00
Interest, insurance and storage charges for the above.....	245.00
Power (7,500 kw.-hr. @ 1½c.).....	112.50
Maintenance and repairs, labor and material.....	250.00
	$922.50

$3, for electric tractors, exclusive of the operator's wages, and gives the cost of operating a gasoline industrial tractor, exclusive of the operator's wages, at $4 to $4.50 per day. This latter company finds that the total cost of owning and operating trailer units is $0.03 per day per unit.

Dragline-scraper conveyor costs have been obtained by Sauerman Bros., Inc., from a large number of installations of their equipment. These figures are given in Tables XXXI and XXXII, and can be summarized here as follows: For storing and reclaiming coal, from $0.028 to $0.045 per ton for a 200-ft. haul; for storing and reclaiming crushed stone, from $0.06 to $0.095 per ton for a haul varying from 50 to 275 ft.

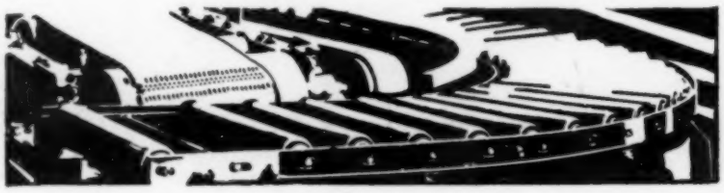
Costs of handling by conveyors or overhead equipment can most readily be estimated by considering each conveyor or other unit separately. From the load handled, with a reasonable assumption of power losses, the power required can be estimated. Cost of power per kilowatt-hour, multiplied by the number of kilowatts of power required, multiplied by the hours of use, will give the cost of power for a given amount of handling. Dividing this cost by the pounds, tons or other quantity units of the material handled will give the power cost per unit handled.

Cost of labor can be estimated in the light of the current wage rate in the locality where the equipment is to be located, by analyzing the handling operation and estimating as nearly as possible the amount of attendance necessary. It should be borne in mind that frequently one man can attend to several duties and divide his time between the handling equipment and other work. Often additional investment in automatic loading, unloading and controlling devices will be justified by the decrease it causes in handling-labor expense.

Maintenance cost for equipment, unless the service be unusually severe, can usually be estimated at between 2 and 5 per cent of the cost of the equipment.

Depreciation can in most cases be estimated on the basis of a life of 20 years for permanently installed equipment and 10 years for movable or portable equipment.

Interest on investment, taxes, insurance, and the possible effect of obsolescence also should be considered in estimating costs of materials handling equipment.



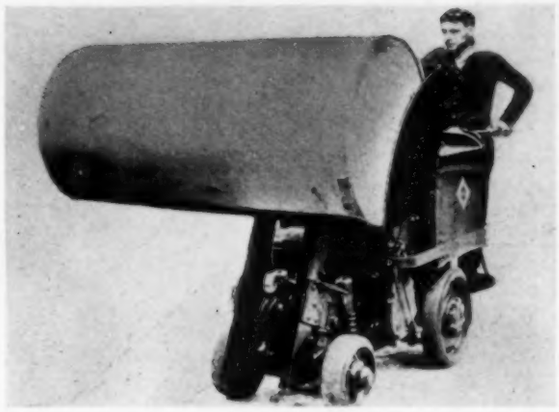


Fig. 1—Scoop Truck Used for Handling Rolls of Rubberized Fabric

Handling Equipment Effects Economies In a RUBBER Factory

By JAMES A. LEE
Assistant Editor, Chem. & Met.

DID YOU EVER stop to consider why the price of the average size automobile tire today is only one-half as much as it was ten years ago? The most important reason for this striking reduction is that the plants producing tires have been about 70 per cent "conveyorized." This installation of automatic handling equipment has resulted in numerous economies, among the most important of which are: (1) a reduction in the number of workmen from five or six to one, (2) a saving in floor space of about 30 per cent, (3) a lowering of the number of defects, (4) utilization of pace setting, which causes the workmen to work at a smoother and faster rate, and (5) a large decrease in the number and seriousness of accidents. A splendid example of a conveyorized tire factory is the Chicopee Falls plant of the Fisk Rubber Company, where straight-line flow of materials and co-ordination of succeeding process operations characterize the layout, and where each step in the production of tires and inner tubes dovetails into the next.

To begin with, raw materials for each batch of compound are weighed into batch-boxes in the basement. These boxes travel along on a gravity roller conveyor, illustrated in Fig. 2, and pass the inspector so that the weights of the materials can be checked. Electric trucks then transport the boxes of raw materials up a long ramp to the mixing mills on the floor above. When the mixed stock comes from these mills, it is put by workmen upon a belt conveyor, which carries it to the feeding mills. From this mill another short belt conveyor transfers it to the calender. The stock leaves the calender on a long belt conveyor, passes through a trough filled with cool water, then over scales, and, while still on the conveyor, is cut into strips for treads.

In order to have a reserve supply of these strips for the tire builders, a special truck has been designed and constructed which serves as temporary storage for more than 200 treads. In appearance it resembles a large mobile book, the steel frame of which supports rods upon which the cloth leaves slide as they do in a loose-leaf binder.

In the stock-preparation department the cotton threads come down in parallel formation from many hundreds of spools located in the creel room above, and pass between two rolls of a calender. Simultaneously two sheets of rubber, coming from

Fig. 2—Roller Conveyor Carrying Batch-Boxes of Raw Materials

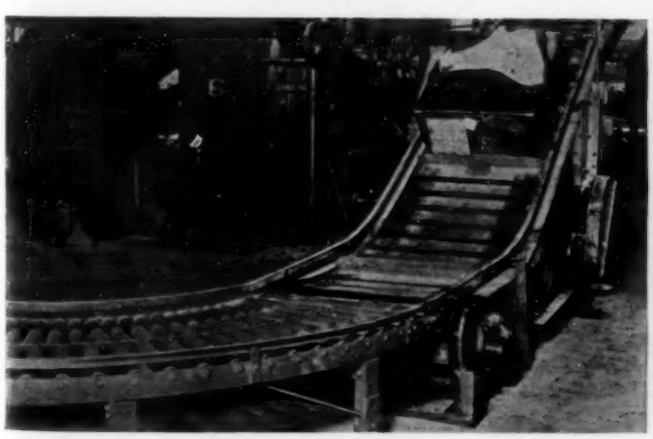


Fig. 3—Belt Conveying Inner Tubes to the Workers for Packing Into Cartons

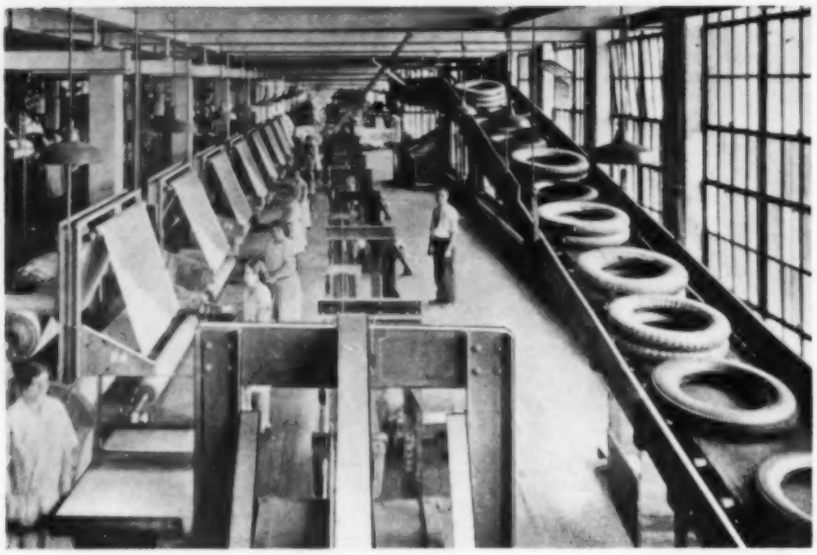


Fig. 4—Belt Conveyor Carrying Tires to Storage Department

other calenders, one on either side of the cotton threads, pass between the rolls and are pressed into and around each thread of cotton, forming rubberized fabric, which is made into rolls as it comes off the calender.

An electric truck, illustrated in Fig. 1, handles the rolls of rubberized fabric. This truck originally was developed for handling rolls of paper, but has been modified to meet the requirements of the rubber industry. It is provided with a large scoop, which can be rotated so that it is possible to unload or pick up the rolls either in a vertical or horizontal position, and is equipped with an elevating attachment so that it may deposit the rolls at various heights. This truck conveys the rolls of rubberized fabric from the calenders to the cutting machines and to the machines which make the bands. Chain conveyors carry the strips of rubberized fabric to the tire assembling department. They also carry the treads, beads, chaffing strips, padding, and breaker combinations which are used by the tire builders.

The chain conveyor has become an integral part of the tire plant and probably is its most characteristic piece of equipment. It is generally suspended from the ceiling and, therefore, permits an enormous saving of floor space. This type of conveyor in some cases is hundreds of feet in length, passing from one floor to another and even from one building to another. It often resembles a roller coaster which suddenly swoops down from its position near the ceiling, so that the materials which it is carrying will be within reach of the workmen, and again returns to its higher position, where it is out of the way of men and machinery.

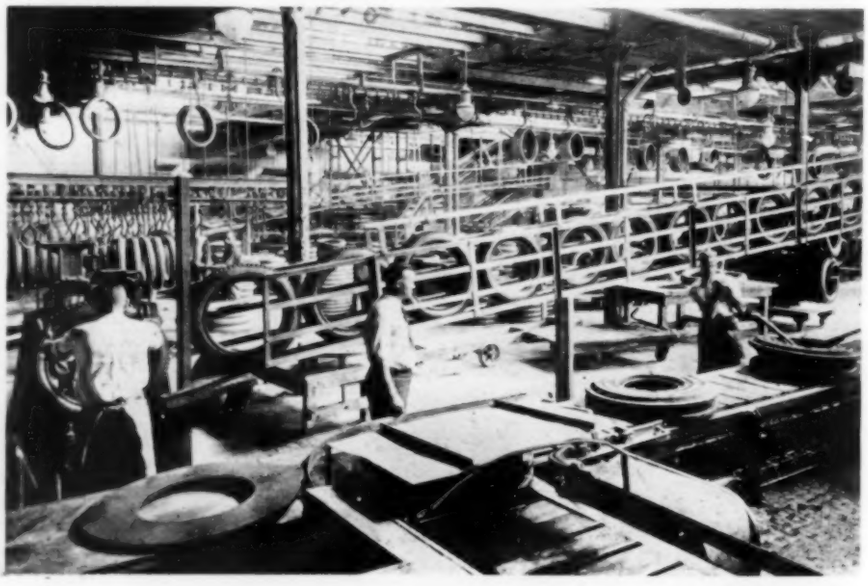
The tire curing department of the plant is a mass of mechanical handling equipment, as can be seen by an inspection of Fig. 5. In this room almost every type of tire-handling equipment is used. The battery of heaters, in which the curing process takes place, is arranged beside a series of pallet conveyors. The tires are put into heavy molds and placed in the vulcanizing pit. From the heater the molds move along to the point where the covers are lifted by a conveyor and workers remove the tires, and clean and refill the molds. The cured tires are then put into a chute and rolled along to the point where the air-bag-removing machine is located and from there to the inspection department.

Chain conveyors carry the completed tires from the curing department to the inspection department. Here they are transferred onto a series of belt-driven, line-roller conveyors set up in parallel, which in turn carry the tires to the various groups of operators, such as trimmers, balancers, inspectors, and those who wash, paint, and stencil the tires. These operations completed, the tire is returned to the belt conveyor superimposed over the line-roller conveyor. It is then conveyed to the next group of workmen by another bank conveyor. This type of automatic handling equipment has the advantage over the other types, of keeping each operator supplied with a reserve, thus avoiding needless delays.

Inspected tires are conveyed on chain conveyors to the wrapping machines. The operators of these machines remove the tires from the conveyors and, after the tires are properly wrapped, replace them on the same conveyor, which carries them to the storage or shipping department. At this point the tires leave the automatic handling equipment and are distributed to the various sections of the storage building on gravity conveyors. Chutes load them into railroad cars for shipment.

Up to this point, only the handling of the materials used in building tires, and the tires themselves, have been considered. It has been shown how the raw materials are transferred to the mills for compounding purposes, to the calenders, stock

Fig. 5—Many Types of Conveyors Are Used in the Heater Room



preparation, tire building, curing, inspection, and finally to the storage and shipping departments. The compounding materials for inner tubes and the tubes themselves are handled in much the same manner.

Several systems are in use in the Fisk plant for producing and subsequently handling tubes. In the case of one system all the operations between the calendering and vulcanizing are tied together by one conveyor system. As the stock comes from the calender it is transferred by a belt conveyor. While still on this conveyor it is weighed, cut into strips, and rolled onto the mandrel. Workmen then remove the mandrels and the uncured tubes, and place them upon trucks. These trucks, loaded with tubes, are then run into the horizontal vulcanizer. After the curing process is completed, the tubes are removed from the mandrels, which are replaced upon the belt conveyor, and returned to the starting point, and the cycle is repeated.

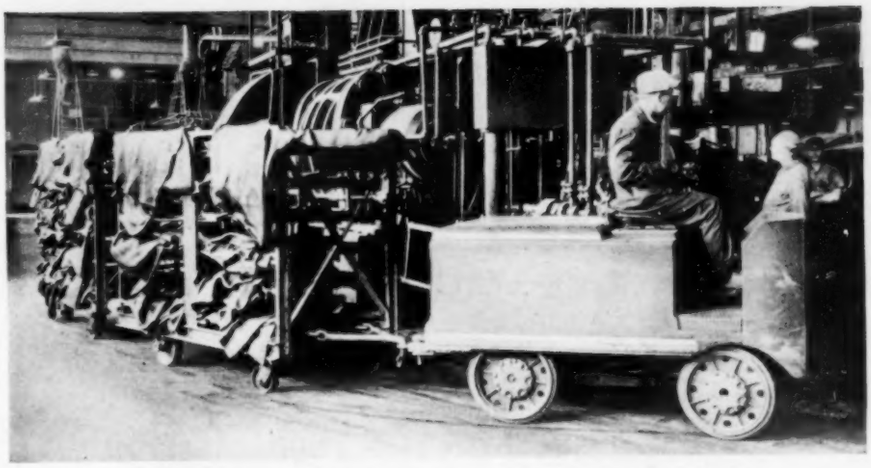


Fig. 7—Electric Trucks Are Used for Transporting Sheets of Rubber

Cured tubes are then placed upon another belt conveyor which passes the group of inspectors, who remove defective tubes. As the tubes pass along this conveyor, workers on either side of the pallet perform such operations as buffing the ends of the tubes, punching the valve holes, and cementing the tube ends. After the tubes pass through a drying oven they are removed, the ends put together, and the splices are cured. They are then inspected, packed in paper cartons, and delivered to the storage or the shipping department.

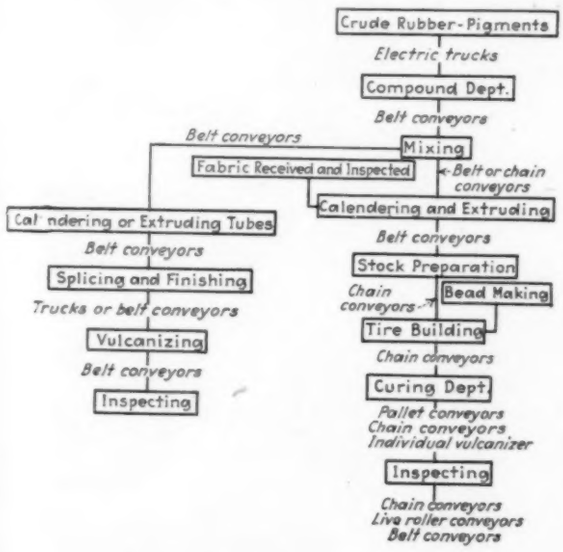
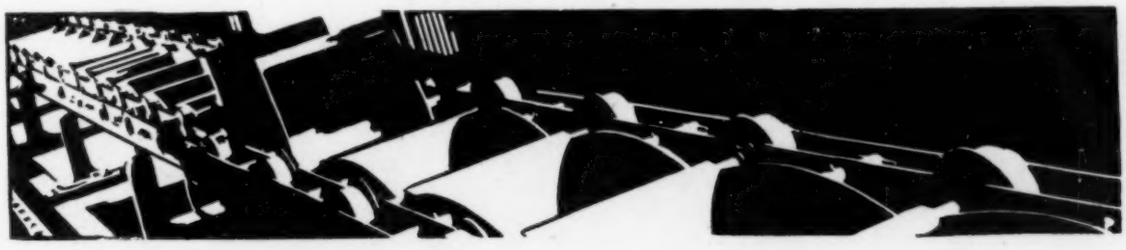


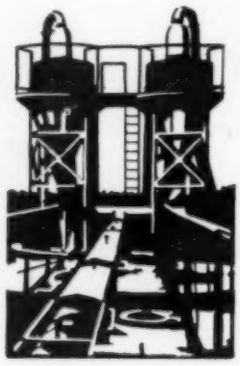
Fig. 6—Flow Sheet Indicating Some of the Applications of Automatic Handling Equipment

The engineers of the Fisk company have developed a new method for making tubes by a molding process. This method is rapidly supplanting the older method of curing on a mandrel. The tube stock is prepared on the mills, then fed by a belt conveyor to the warming mills and to the extruding machine, from which it emerges in the form of a tube. This tube is fed onto a belt conveyor, and is passed through a long tank of cool water and over an automatic scale. Operators put on the valve pad, cut the long rubber tube into shorter lengths, buff and skive the ends of each tube, and splice them together. These operations are performed while the tubes are still on the belt conveyor. Another conveyor carries them to the vulcanizers. Afterward they are carried into the inspection department described above.

The engineers will be kept employed for many years adapting and developing automatic handling equipment in the rubber industry. New processes of preparing and curing the stock will furnish new problems in conveying. Such developments as the individual tire vulcanizer, which probably will replace the multiple type used at present, will require the complete remodeling of the conveyor system used in the heater room; there also will be a general simplification of handling equipment such as the elimination of trucks and skids.



Modern AMMONIA-SODA Plants Capitalize on Economies of Mechanical Handling



By L. C. HUGHES

Chemical Engineer, Elizabeth, N. J.

EFFICIENT handling equipment in an ammonia-soda plant for the production of soda ash is a most important factor because of the sizable tonnages involved and the consequent opportunity for labor saving. The industry as a whole has been aggressive in this direction, particularly in America, where labor cost is high, and as a result certain of the handling problems which are still more or less crude in some industries have been worked out extensively in soda ash production. This is especially true in the lime burning, which has reached a point not approached in any other of the lime-using industries either in the matter of material handling or fuel economies.

In order to point out some of the material handling problems met in the alkali industry, it is necessary to consider a flow sheet of the process itself and also go into the handling of the principal raw products even before they enter the process.

Limestone, which is one of these raw materials, has to be quarried and it is necessary that the most up-to-date handling equipment be used. Details of this equipment will not be discussed here, as it is fairly well standardized and is used in all large quarrying operations. It may be added, however, that the alkali manufacturers are intensively interested in getting limestone delivered to the plant as cheaply as possible. Manufacturers who have their own quarries have been able to deliver to their plants at costs of less than $0.70 per ton of stone.

Upon reaching the plant the limestone is handled in various ways, depending upon the quantities required and the type of delivery equipment used. Alkali plants located on waterways often receive all of their stone in boats and the most up-to-date boats for this purpose carry a cargo of from 8,000 to 10,000 tons and are equipped with belt conveyors which will unload in approximately 6 to 10 hr. Belt conveyors bring the stone from the hold of the boat and deliver it to a boom conveyor which can swing to any point on shore within a radius of 150 ft. From the boom conveyor the stone may either be stored near the shore line or delivered into dump-bottom railway cars which take it to plant storage. It often happens that the stone as it comes from the boat is not properly sized for plant use and requires additional screening. This screening, of course, should be done at the quarries, but subsequent handling in and out of boats produces some fines, so that it may be desirable to set up some method of handling and screening after the material has been delivered to dock storage.

A large bridge crane of sufficient span to cover the storage space travels on tracks parallel to the shore line and carries a complete screening plant which is fed by the crane bucket. The screened material can either be sent directly to waiting cars or back into stock. The cars are delivered to the plant storage bins, which are arranged underneath a trestle, so that the stone can be dumped into them.

Alkali plants that are not on the waterfront receive their stone by rail in dump-bottom cars. It is discharged directly into bins for immediate use and the excess goes to ground storage. There are different methods of reclaiming from this storage, the principal one being either by bridge crane and bucket or by an underground conveying system which runs beneath the storage.

Coke used for the lime burning comes direct from the ovens by dump-bottom cars. The larger plants have their own ovens and the coke is accurately sized over screens or grizzlies before use at the lime kilns.

THE STARTING POINT of the ammonia-soda process proper is the lime kilns. The stone and coke which have already been followed to plant storage bins, are now ready to be sent to the kilns. They must be mixed in proper proportions for burning, and this can be accomplished either by direct weighing or by volume measurements. The latter is now followed by most of the manufacturers, but there are still adherents to the other method.

The weighing of stone and coke can be done in a number of ways, some methods being much more efficient than others. A system now in use is as follows: The stone and coke bins are set high enough to allow a larry car to run beneath. The car is electrically driven and carries a bin mounted on scales. It requires two men for the operation, one at the electrical controls and the other to draw and weigh the stone and coke. After the car is filled and weighed it is run to a pit, where it dumps into a bucket and the material is then elevated to the top of the kilns. The bucket which has been hoisted by an electric crane then travels across the kiln tops until it arrives at the kiln to be charged.

The system of volume measurements for stone and coke varies considerably from the above and in substance is as follows: The stone and coke bins are equipped with apron feeders at the bottom for discharging their contents. There may be any

number of bins, depending upon the tonnage to be handled, but each stone feeder is synchronized with a corresponding coke feeder, with one motor as a drive for the pair, in order that the discharge of one bears a fixed relation to the other. It is then possible by means of an adjustable gate or plate to make the small changes necessary at times when needed for increasing or decreasing the percentage of coke. It has been found that a change of $\frac{1}{4}$ in. on this gate will make a perceptible difference in the coke used. The apron feeders are not run continuously, and for this reason are under timed push-button control which has been calibrated by weighing the discharge over a time interval. They discharge on a belt conveyor which takes the material on an incline to the top of the kilns and then across, in order to charge the different kilns by means of a traveling tripper. In the case of a small plant, where only one or possibly two lime kilns are used, it is often customary to use a skip hoist for delivering to the top after the material has been proportioned by the apron feeders, and this equipment is all so automatic that a part-time operator takes care of everything from the ground.

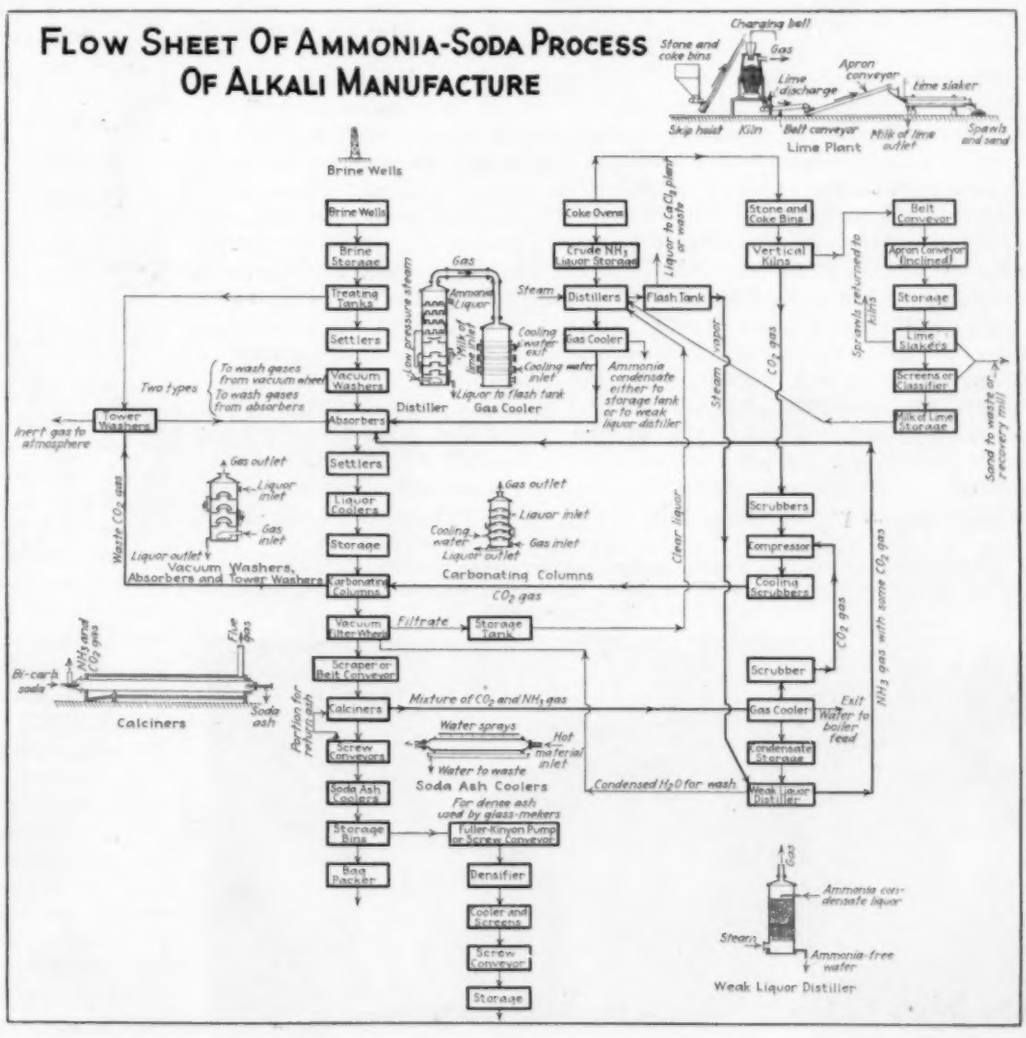
The lime kilns used in the alkali industry are large, some of them having a capacity of 400 tons or more per day per kiln. They are operated under blast, and the charging and discharging mechanism is practically automatic. In the discussion so far the stone and coke has been brought to the point of charging, but between this point and getting inside the kiln there is considerable equipment which often is a large factor in determining the efficiencies of burning. Unfortunately, it is not possible to discuss this subject here, but it may be stated that the most efficient apparatus for this purpose was originally designed in Europe.

The discharge mechanism also is quite complicated in design, although simple in operation. It is operated at intervals by push-button control and after leaving the kiln the material is discharged on a belt conveyor. The belt either takes the burnt lime up an incline or it is discharged to a pan conveyor which serves the same purpose and delivers to a storage bin, which in turn feeds the slaking equipment. The milk of lime is separated from the coarse sand and spalls while in the slaker and is sent to screens and then to storage for further use. The sand is either thrown away or sent by belt conveyor to a recovery mill which grinds it and then returns it as milk of lime to the main storage. The spalls of proper size are returned to the kiln for reburning.

NO FURTHER dry material handling is encountered in the ammonia-soda process proper until after the sodium bicarbonate is precipitated and filtered. It then drops from the filter wheels to a two-deck scraper conveyor which carries the material to the feed machines of the different calciners. From the calciners it is taken by a system of screw conveyors to coolers and screens, and then elevated to light-ash storage bins. The conveying system also provides for a partial return of the finished ash to be mixed with the bicarbonate entering the calciner.

Light ash from the storage bins is either shipped in bulk or bags or is further processed for the production of dense or granular ash for the glass manufacturer. In making the granular ash the light ash is handled from the bins by screw conveyors as a rule, although the Fuller-Kinyon pumping system also is used. Pumping powdered materials by this method has found considerable application in recent years and often offers advantages which are worth while.

No attempt has been made in the foregoing to point out all the possible methods of material handling, or even to mention all that are now in use. All that can be offered is an outline of how some of the major handling problems have been met by some of the plants. It is obvious that the best solution depends entirely on the special conditions existing with each manufacturer.



HEAVY HANDLING

Characteristic of

SUPERPHOSPHATE

By McKEE BARCLAY

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SUPERPHOSPHATE — the "acid phosphate" of former days before the term "acid" took on invidious implications for the farmer —is acidulated, pulverized phosphate rock. The Davison Chemical Company is one of the largest producers of superphosphate and, as its equipment and methods are thoroughly modern, a description of its handling of the product, from the mines to the point of final distribution, may be considered typical of up-to-date organization.

Davison, operating through one of its subsidiaries, the Southern Phosphate Corporation, has 10,000 acres of phosphate-bearing land in Polk County, Fla., containing over 25,000,000 tons of land pebble phosphate rock. It has three separate plants, consisting of mining equipment, hydraulic guns, storage bins, standard-gage railroad, draglines, suction dredge, grinding and washing machinery, and so on. Through its hydraulic guns pass 15,000 gal. of water per minute, which removes 2,000,000 cu.yd. of the phosphate-bearing stratum per annum. When the amount of overburden removed by the dragline is added to this, the figures rise to 6,000,000 cu.yd., or about one-sixth of the amount of earth moved in any one year during the digging of the Panama Canal.

Stripping of the overburden at the Davison mines is done by three Bucyrus electric draglines, two of them equipped with 8-yd. buckets and one with a 6-yd. bucket. One dragline has a 125-ft. boom, another a 135-ft. boom, and the third a 141-ft. boom. The three can handle 550,000 cu.yd. a month. Cuts run from 1,000 to 2,000 ft. in length, and usually from 175 to 210 ft. in width.

Rock for Davison's subsidiaries in various fertilizer centers goes by rail, with the exception of that going to its plant at Gulfport, Miss., which is shipped in 4,000-ton steamers, and the cargoes consigned to the parent plant at Curtis Bay, on Baltimore Harbor, which are loaded in 5,000-ton vessels through large modern elevators and samplers located at Port Tampa.

The phosphate unloading pier at the Curtis Bay plant is a steel and concrete structure about 400 ft. long. Gantry cranes unload the rock at the rate of 7,200 tons in 24 hours and carry it to dump cars which are hauled by electric locomotives into the superphosphate plant.

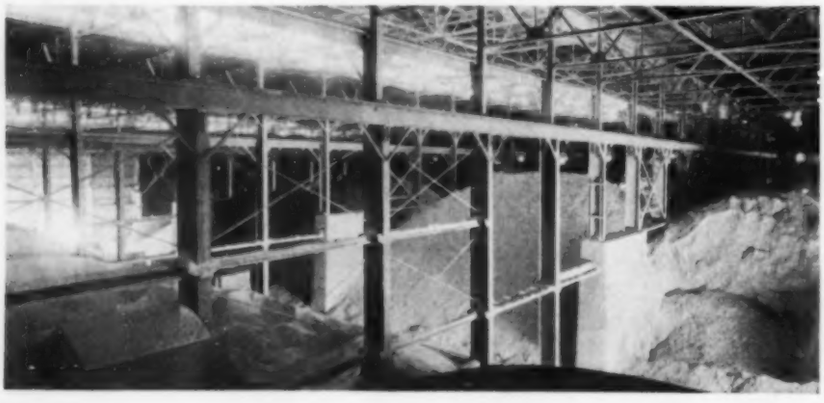
This building is 375 ft. long, 300 ft. wide and 60 ft. high. It has four 75-ft. bays equipped with 3½-yd., grab-bucket, traveling cranes. Three of these bays are for production operations and the fourth for storage purposes. Actual working tonnage of 16 per cent superphosphate for the building is 50,000 tons but, fully loaded, it has a capacity of 75,000 tons.

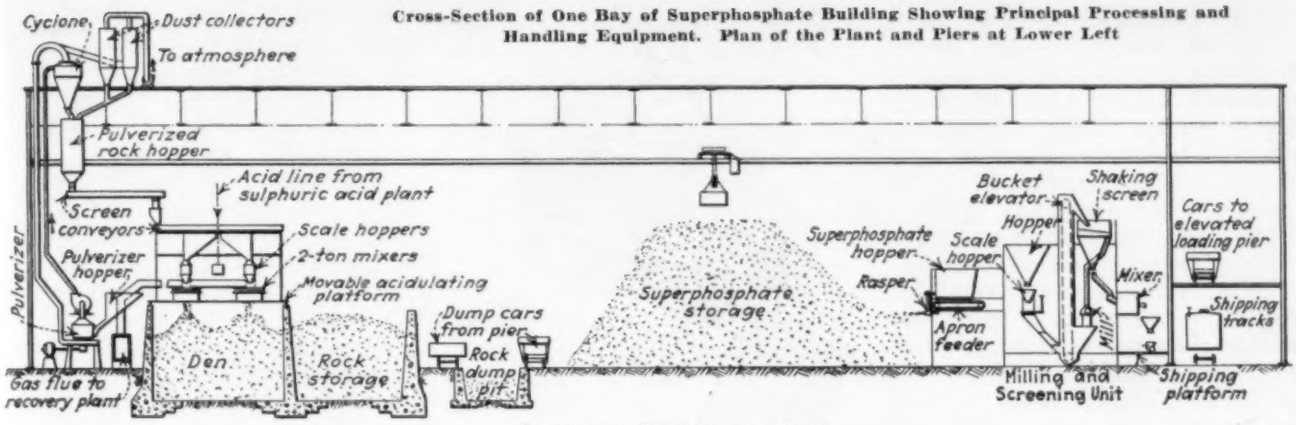
The accompanying flow sheet of one of the bays shows the course of operations which follow the receipt of the rock from the mines. The rock is picked from the dump-car pits by the overhead cranes and either put in the rock storage bins or fed direct into the pulverizing hoppers. From this point it is automatically fed into impact pulverizers, from which the ground rock is pneumatically conveyed to the overhead storage hoppers at the extreme end of the building. From this point, spiral screw conveyors transfer it to the acidulating platform, where it is weighed in batching scales with dial indicators.

It is next dumped into mixers, where the exact quantity of acid required is pumped direct from either the company's chamber plant or from its contact units. The latter are unique in that they employ the platinized silica-gel contact mass in their converters instead of using the platinum catalytic mass with the older type of carriers.

Superphosphate Pier Showing Electric Locomotive, Cars and Gantry Cranes

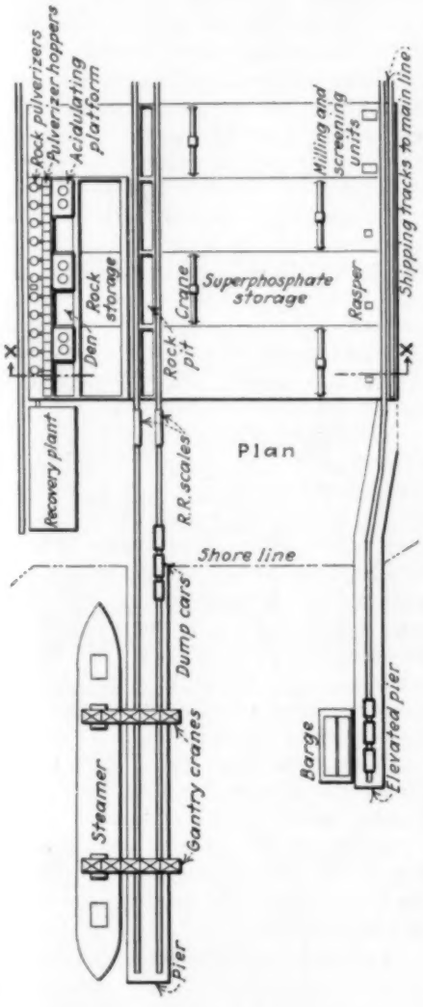
View Across the Davison Superphosphate Building From the Mixing Platforms, Note Crane Tracks; Cranes at Far End. Wharf Car Tracks and Rock Dump in Valley in Foreground





Cross-Section of One Bay of Superphosphate Building Showing Principal Processing and Handling Equipment. Plan of the Plant and Piers at Lower Left

Sectional Elevation on X-X



After mixing, the batch is dropped into one of this bay's two 400-ton concrete dens. There are two mixers, mounted on a structural movable platform which completely covers one of the dens. This platform is mounted on tracks and, when one den is filled, it may be moved to the next den and the operation repeated.

Superphosphate in the uncovered den is then picked up by the overhead crane and transferred to the far end of the building, where it is fed into a conditioning unit consisting of a hopper with an apron conveyor. This feeds it to a high-speed rasper, a device which breaks up the product, aerates it, drys it, leaves it in an extremely granular condition and throws it out into the storage bay. From this pile it is picked up by the overhead crane and moved forward to the position from which it is to be loaded for shipment as run-of-pile superphosphate.

The process described covers the manufacture in three of the four production bays. The fourth bay is used for the production of ammoniated and reduced 16 per cent superphosphate. This bay is also equipped with an overhead crane and two milling and screening units which each have a capacity of 40 tons an hour.

Shipping facilities include loading tracks and two shipping piers. The larger of these piers is equipped with two gantry cranes for unloading rock and for loading large steamers and schooners with the finished product while the second pier, at the end of the building, is equipped with an electric locomotive, dump cars, and chutes for loading small barges and schooners for bay and inland waterway traffic.

Below the overhead track that feeds the piers are two railroad loading tracks for box-car shipments which can be serviced from any one of the four bays of the building.

In the building described, 1,500 tons of superphosphate can be produced daily and it is possible to ship from it as much as 9,000 tons per day. The annual capacity of the plant is rated at over 400,000 tons. It has all-rail connection with the Baltimore & Ohio Railroad, besides a carfloat connection with all three of the trunk lines entering Baltimore.

COST and QUALITY Ban Wheelbarrow in CERAMICS

By HOBART M. KRANER

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HANDLING raw materials in the several branches of the ceramic industry presents two definite aspects. In the manufacture of heavy clay products, and perhaps terra cotta, the volumes of material consumed are large and the materials are of a rather low grade. Although quality and character of these materials do make a difference in the quality of the resulting product, they do not need to be handled and tested as carefully as is necessary in the finer wares. In the heavy clay-products industry the matter of handling these large tonnages of raw materials by mechanical methods is an economic necessity.

The whiteware industry manufacturing sanitary ware, floor and wall

tile, dinnerware, and electrical porcelain uses high-grade clays, ground flint, and ground feldspar in large quantities. All of these are of the highest purity. Their uniformity of plasticity, purity, grain size and other characteristics, are important to the success of the industry. Methods used in handling these raw materials at the plant must necessarily be such as to maintain these conditions. It very often happens that it is for these reasons alone that certain mechanical methods of handling raw materials are selected in preference to others which apparently are more economical.

Even though the materials used in the whiteware plant are of the best grade used in the industry they must be used as received and their lack of uniformity may seriously affect the product. Flint used is a washed, pulverized sandstone. Its purity usually is 99.5 per cent SiO_2. Its fineness will vary with conditions maintained at the grinding plant. Feldspar may vary in composition with the degree of uniformity maintained in sorting the rock. Its fineness may vary with the grinding practice of the producer.

Clays used vary in uniformity in accordance with their mode of occurrence in the deposit, and to a certain extent with the practice of the miner in selecting the material. This is especially true in the case of the ball clays, which are of secondary geological origin and therefore somewhat more impure and variable in character. A system of handling which will place these raw materials in the bin so that on withdrawal an average of a number of cars of the raw material is obtained, is highly desirable.

What method to employ in putting these raw materials into the bins will depend to a large extent upon the quantity handled. A whiteware plant using a total of 500 tons of these raw materials per month is considered a

large one, and there are only a few ceramic plants other than those manufacturing heavy clay products which use more than this amount. When 500 tons is divided into the different bins for the various clays, flint, feldspar, and so on, it is necessary for a conveyor to handle only about 100 tons of material per month into each bin. This, of course, is a very small amount of work to require of an expensive handling equipment, and in many plants this is the reason given for adhering to the old wheelbarrow method of unloading. By this method the direct labor charge is only 20 to 25c. per ton. Indirect charges are almost nil. Where mechanical equipment is used for handling these raw materials, the direct labor of the attendant usually is 5 to 8c. per ton. The indirect charges are often as high as 20c. per ton, in view of the large initial cost of the equipment, the high maintenance costs, and the small tonnage handled. Maintenance costs per ton probably are proportional to the tonnage, but the investment charges per ton are inversely proportional to the quantity of material handled in the bin.

In many cases where mechanical equipment is used in conveying the raw materials, the layout is designed to provide a method of subsequent handling of the stored material so as to save in proportioning labor, to produce greater uniformity, to save in floor space, or all of these. One method which is impossible with the wheelbarrow-manpower system is the elevation of the materials into a high bin or silo from which they may be withdrawn by gravity. This method, because of the ease and lower cost of proportioning and handling out of storage, has advantages which often render it preferable to the wheelbarrow method and is therefore becoming quite popular, in spite of its slightly higher cost.

With the foregoing in mind, we cannot say that the wheelbarrow-manpower method of unloading and handling raw materials is to be recommended in face of the advantages of conveyor systems, even though the latter cannot be entirely evaluated.

There are several pneumatic systems now being used to handle pulverized materials. One of these embodies a vacuum system by which the powdered materials are drawn to a central, elevated collector unit which separates the air and solids, letting the latter drop by gravity into the bin. This type handles only finely ground, light material and therefore is not adaptable to handling of coarse clays, for which other means of movement must be provided.

Another type of pneumatic system aerates and blows the pulverized material for long distances and to appreciable heights, readily filling silos and other types of storage space. This equipment is relatively simple, is adaptable to remote routing control, and only one blowing mechanism is required for several sets of pipes used to carry different materials to the respective bins or other storage spaces. The same limitations exist for this system as for the method described above; since it does not handle coarse clay particles, and therefore is not universal equipment for all the materials used in the plant, another system is needed for the coarse materials.

A conveyor system shown in Figs.

Fig. 1—Handling System Described, Being Used for Unloading Cars and Loading Clay Storage Bins

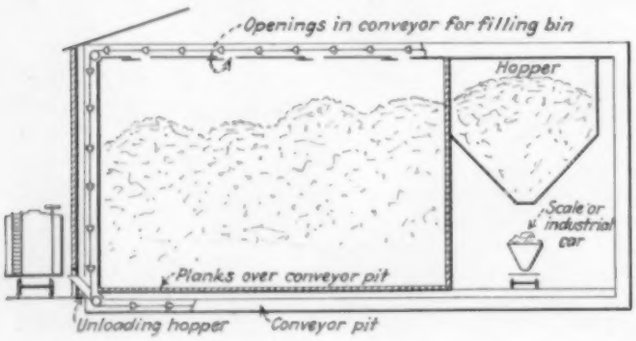
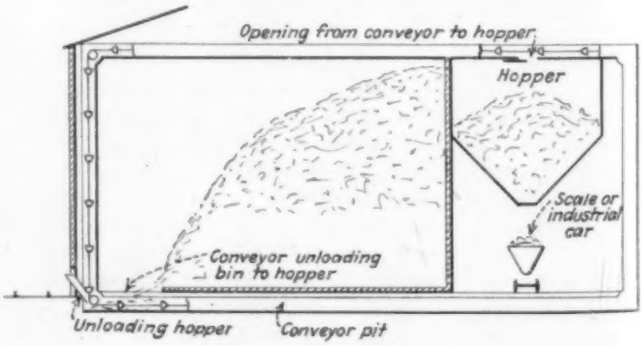


Fig. 2—In Reclaiming From Storage, Conveyor Takes Clay From All Levels, Insuring Adequate Mixing



1 and 2 has operated satisfactorily, fulfilling the requirements outlined. It utilizes the same equipment for both loading and unloading, in the manner described above as highly desirable for ceramic raw materials. It reduces the labor cost incident to weighing batches of raw materials by elevating the materials to an auxiliary hopper, as shown.

When materials are unloaded they are picked up by the conveyor and dropped through the holes in the horizontal trough at the top of the bin at any point desired, and in such a way as to distribute the contents of one car in a horizontal layer over the whole bin. Succeeding cars also are distributed in the same manner. How this is accomplished is shown in Fig. 1.

Later, when the bin is to be unloaded, the material is cut vertically, thus delivering an average of a number of cars of material. Withdrawals are carried by the same conveyor to the hopper from which the materials are dispensed to the scale car. Fig. 2 indicates this phase of the operation.

The cost of raw materials constitutes only a small percentage of the manufacturing cost of the finished product. Obviously, a small increase in unloading cost adds little to the cost of raw material or finished product. But the greater uniformity of raw materials resulting from their handling in such a systematic manner undoubtedly will net results that outweigh the slightly increased unloading costs which may be involved.

All of the foregoing seems to indicate that many factors must be considered in selecting the most suitable handling equipment for ceramic raw materials. It indicates, further, that it is short-sighted to consider only the unloading costs when many incidental advantages may be gained through the use of certain systems of mechanical handling.

FLINT and FELDSPAR

Plant Employs Pumping of Dry Solids

By H. P. MARGERUM

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MANY PRODUCERS of ground feldspar have found that it is a very difficult material to handle in mechanical conveying systems. This was especially true before the advent of continuous grinding and is still the case in some parts of the industry. Ground feldspar is quite abrasive, but the chief difficulty arises from its tendency to pick up moisture from the atmosphere, cake solid in chutes and bridge over in hoppers. Our plants have overcome these difficulties, however, through the use of specially selected conveying equipment and continuous processing.

The Golding & Sons plant of Consolidated Feldspar Corporation, at Trenton, is an example of the completeness with which a program of mechanical handling can be worked out in this industry. Ground feldspar and French flint are produced for the pottery trade, principally in sizes of 98½ per cent through 200 mesh and 96 per cent through 325 mesh.

Both kinds of rock are brought into the plant in box cars and unloaded to storage. Flint requires a preliminary calcining before it can be crushed and is consequently unloaded by locomotive crane and piled in a storage yard from which it may be reclaimed as needed by means of a dragline scraper. Feldspar, on the other hand, is ordinarily forked directly from the cars into a primary jaw crusher. Although the rock is sorted at the mines, hand unloading has been found desirable, because a certain amount of selection is necessary. Because of the high grade of product required for the production of white wares, particular pains must be taken to avoid the introduction of stained rock into the crushing operations. It is equally important to prevent the introduction of any iron. In addition to the magnetic separators that must be employed, conveying and other equipment must be chosen with this requirement in mind.

From the crusher the rock is lifted by a bucket elevator to a horizontal belt conveyor which discharges to any one of four elevated concrete storage bins, each of 250 tons capacity. Beneath the bins is a track upon which a short transfer conveyor may be moved from bin to bin to receive the feldspar as it is withdrawn. This belt discharges to a stationary belt conveyor, perpendicular to it and running the length of the bins. Discharge from the longer conveyor is to a secondary jaw crusher located in a pit below the floor level. From the secondary crusher the rock is elevated by a bucket elevator to a divided spout above the roof, from which it is delivered either to a dryer or an elevated feed bin placed before the ball mill.

It usually is necessary to dry the rock, which may contain up to 8 or 10 per cent of moisture and should enter the ball mill with less than 1 per cent. The dryer is of the tower type, consisting of a vertical steel casing containing baffles over which the rock cascades through the hot combustion gases ascending from a small coke-fired furnace. The dryer discharges to the boot of a second bucket elevator which raises the rock and chutes it over a magnetic pulley into the ball-mill feed bin. From the bin the rock drops to an 8 x 5-ft. Hardinge conical ball mill equipped with an air separator. Properly sized material passes over a Richardson automatic grain scale to an intermediate storage bin and then to a 4-in. Fuller-Kinyon pump, rated at 7 tons per hour, discharging to the finished storage bins.

The feldspar unit of the mill was originally designed to use belts and elevators in conveying the finished product to storage. To protect this equipment it was necessary to build a monitor over the storage bins. When it was decided to substitute the pump for the original equipment, the monitor was no longer required. When the flint unit was added, designed also to use a pump, the monitor was omitted. It is an interesting fact that the omitted monitor paid for the new pumping system, leaving the cost of comparable conveying equipment as so much clear saving.

Aside from the saving in investment, the pumps have been found to reduce the chances of iron contamination at this stage of the operations to negligible proportions. Although their power consumption is estimated to

Fig. 1—Above: View in Monitor Over Feldspar Bins Showing Pump Lines and Two-way Valves

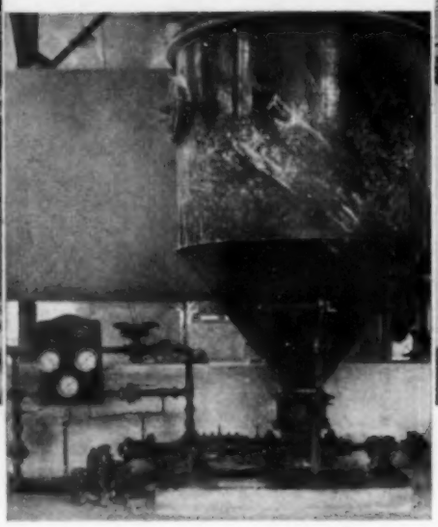
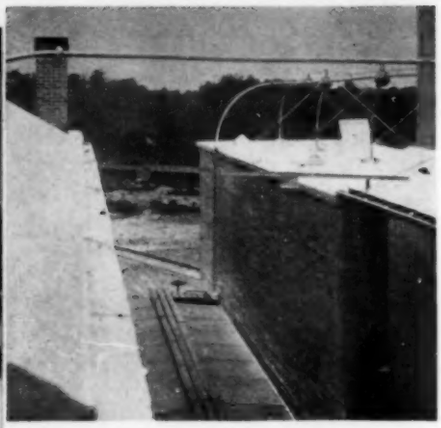


Fig. 2—At Right: Fuller-Kinyon Pump



Connected Below Raymond Air Separator

Fig. 3—Above: Looking Across Loading Track Toward Loading Line and Flint Bins

be about equal to or slightly less than would be needed for a comparable belt and elevator conveying system, additional benefit is derived from greatly reduced shutdown time for repairs, and maintenance only about one-tenth of that of a comparable mechanical system.

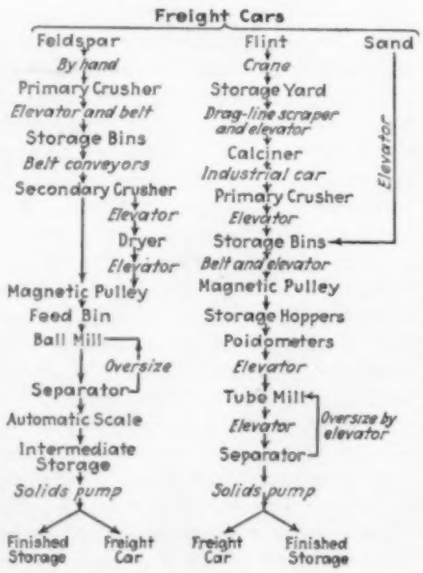
A pump consists of a close-fitting casing in which is a screw propelled by a direct-connected motor of 5 hp. Power consumption varies from 3 to 5 hp., depending upon the moisture content of the material. Material is fed from a chute into the screw and is advanced toward an aerating chamber. The pitch of the screw decreases toward the chamber so as to compact the material and prevent it from blowing back. Compacted material then advances into the aerating chamber, where jets of air from an annular ring cause the particles to become separated by films of air and the material increases somewhat in volume. The pump shaft at this point is protected by a rubber sleeve.

All of the air required by this pump, as well as the one later installed for the flint unit, is supplied by a compressor operated by a 25-hp. motor. This also provides air required for blowing out the pumping lines whenever a lengthy shutdown is contemplated.

Once the feldspar has been aerated, it behaves like a liquid and is forced by the pressure of the screw through a 2½-in. line to six elevated concrete storage bins, each of 100 tons capacity. The distance from the pump to the farthest bin is 122 ft. and the maximum lift is 35 ft. Although the line has been operating more than a year, wear has been negligible, even in the bends. The two-way valves by which the flow is diverted to any of the bins are clearly shown in Fig. 1. A branch line, not shown, is used to fill freight cars directly. It is noteworthy that the material flows directly from the line into the bin, practically without dust, and spreads like a liquid. It is possible to fill the bins completely, although the powder settles about 10 per cent as it is deaerated.

The flint grinding unit is similar in only a few respects. Pebbles are reclaimed from the storage yard by means of a Beaumont dragline scraper and pulled to a hopper feeding an elevator within the building. This lifts the flint to the top of a calciner, consisting of a coal-fired furnace through which the pebbles descend over a sloping tile bottom. Pebbles are raked, without cooling, to a small iron car pulled by an electric hoist.

Fig. 4—Flow Chart of Flint and Feldspar Grinding, Showing Material Handling Equipment in Italics



The car is run up an incline and drops its load into the hopper of an 8x16-in. jaw crusher. The crusher is interesting because of the difficult service it must perform. As the jaws reach a red temperature, manganese steel proved unsatisfactory. High-chromium steel has been used for some time with considerable success.

An elevator hoists the flint to a 250-ton storage bin beside which is a similar bin for sand flint. Withdrawal of either material is to a belt which skirts the base of the bins, running to an elevator. Material discharges from the elevator over a magnetic pulley to either of two intermediate storage hoppers, one for sand and one for flint. Each hopper feeds a Schaffer Poidometer, while the Poidometers discharge to a common elevator boot. Poidometers are used together to proportion a mixture of flint and sand, or separately for either material alone. Control mechanism attached to each will stop the one if the feed from the other is interrupted for any reason, thus making certain of accurate proportioning.

The mixed materials are elevated to a feed bin and dropped to a 6x22-ft. Traylor tube mill, close-circuited with a 14-ft. Raymond mechanical air separator. Oversize from the separator is returned to the mill by another elevator, while the sized material drops to the hopper shown in Fig. 2, and thence to a 4-in., 7-ton-per-hour Fuller-Kinyon pump. The flint is pumped through a 2½-in. line a maximum distance of 140 ft. to four 180-ton concrete bins shown in Fig. 3. In this view the car loading line is plainly visible. The total rise in this case is 31 ft. As with the feldspar pump, a 5-hp. motor again furnishes power for pumping.

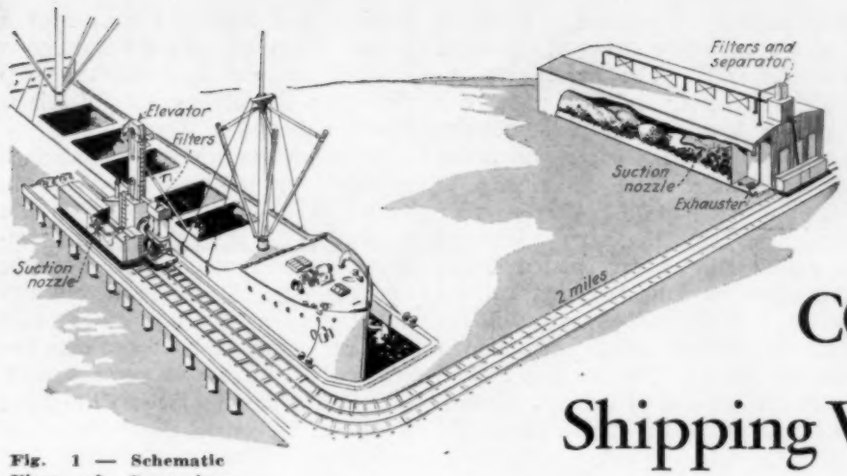


Fig. 1 — Schematic View of Conveying Operations Both at the Storage Building and at the Dock

Cutting HANDLING COSTS in Shipping Vegetable Potash

By JOHN F. BARNARD

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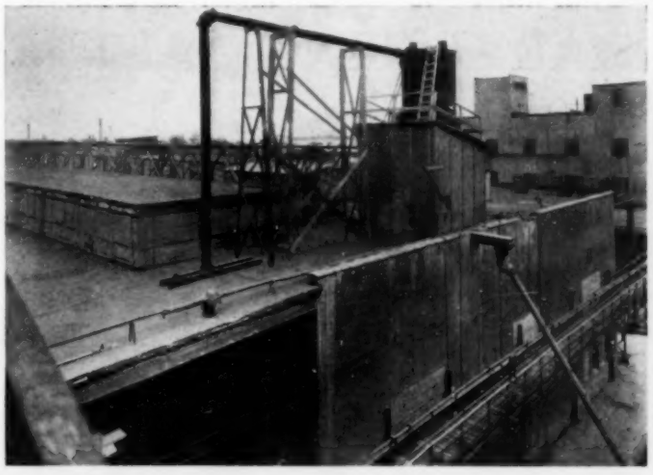
A VERY LARGE tonnage of vegetable potash, consisting principally of KCl and K_2SO_4 in approximate equal proportions, is produced as a byproduct by the U. S. Industrial Chemical Company, and is used by fertilizer manufacturers as the potash ingredient of their product. With many fertilizer plants located on tidewater to receive nitrates from ships, and with the dock facilities already available, it is more economical to transport the material produced at Baltimore by ship; but as the point of production and storage is about two miles from the docks, it is necessary to convey it to the latter point by rail.

The original handling equipment consisted of hand labor for moving the material from storage to a belt conveyor which discharged into gondola cars. Cars were then switched to the dock tracks and transferred over two miles of trackage to docks, where the contents of cars were loaded into the ship by means of a crane-operated clamshell bucket.

The shipment in open gondolas necessitated covering the material with tarpaulins to protect it from unexpected rain showers, and movement was entirely interrupted during severe wet weather. This method of handling also created undesirable working conditions, as well as a loss in material from dusting, both when loading and unloading gondola cars.

Fig. 2—One Operator at the Nozzle Loads 20 to 25 Tons Per Hour

Fig. 3 — Storage Building Showing Suction Piping, Filters and Housing for Receiver, With Spout to Box Car



To improve the situation we consulted the Dust Recovering & Conveying Company, of Cleveland, with the result that a system was designed utilizing this company's three-compartment, Type "A" filters. Operation of the installation indicates that it has the following advantages: (1) Elimination of dust, thereby creating more desirable working conditions; (2) Substitution of box cars for open-top gondola cars, thereby eliminating weather conditions as a factor; (3) Elimination of material loss; (4) Reduction in operating cost.

Handling of the potash from the storage warehouse to box cars is illustrated in Figs. 1, 2, and 3. The material, weighing approximately 60 lb. per cubic foot, is drawn through a flexible hose (Fig. 2), which may be attached to any of several suction connections. It is elevated pneumatically to the receiver on the roof of the building (Fig. 3). The conveying air is exhausted through the three filters shown and through a vacuum pump within the building. From the receiving station the potash flows by gravity to a Pratt box-car loader located within the car. The box-car door is curtained during this operation to retain the dust within. There is no visible discharge from the vacuum pump, which shows that no loss of material occurs in handling. Also the inflow direction of the conveying air at the suction nozzle com-

pletely eliminates the possibility of dust at this point.

This system will load 20 to 25 tons of potash per hour through one nozzle, requiring three operators, as against twelve men for the same capacity, using the old method of handling. The vacuum pump is driven by a 75-hp. motor, actually consuming about 70 hp.

After trans-shipment to the dock, the potash is transferred to ship by a specially designed pneumatic conveyor mounted on a flat car, as shown in Figs. 1 and 4. This installation is portable, but in practice is considered semi-permanent, because it is found easier to move the string of cars than the conveyor. The usual arrangement of receiver and filters has been modified to meet the height restrictions specified for clearance under railroad bridges, but the principle is identical with that of conveyors of more conventional design. Material is drawn from a car spotted beside the conveyor into a cylindrical receiver, and the conveying air is exhausted through three filters and a vacuum pump. The latter is housed in at the left end of the car. Potash is discharged to the elevator from the receiver and filters by means of a screw. From the elevator material is directed to the hold of the ship through a flexible spout. All this is clearly indicated in Fig. 1.

A car puller at the end of the dock is used for spotting cars, and in operation the ship to be loaded is first moored at the dock close to the conveyor. Hand manipulation of the two intake nozzles inside the car permits unloading at a rate of 15 to 20 tons per hour. About six cars are required to fill a hold compartment, after which the ship is moved to bring a second empty hold alongside the conveyor. Five men handle the equipment, as against six with the previous method, and the total power consumption is found to be between 70 and 75 hp.

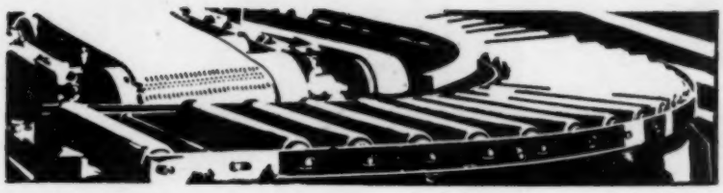
The pneumatic equipment has been in operation over two years, and has shown that it is dependable and durable. The power consumption is higher, but the labor involved has been cut in half; the material loss in spillage and dust eliminated; working conditions have been greatly improved; and a more convenient conveying system has been developed for this service.

Fig. 4—View of Portable Pneumatic Unloader on Dock; Vacuum Pump Under Housing at Left, Elevator in Center and Receiver and Filters at Right; Note Suction Hoses

HARVESTING SALT in California

Alviso Salt Company, Alviso, Calif., boasts a unique method of harvesting solar-evaporated salt. Sea water is pumped through 12 miles of ponds, becoming increasingly concentrated in NaCl and losing impurities by crystallization, until it reaches crystallizing ponds totalling 350 acres. When the salt crystals have been formed, they are plowed up by the harvester shown in the upper view, consisting of digging and conveying equipment mounted on a Caterpillar tractor. Harvesting is at the rate of 180 tons per hour, requiring two men and part-time service of a third, compared with 50 men by the shovel method. Salt is discharged to a series of four Stephens-Adamson belt conveyors mounted on crawlers electrically driven in synchronism. The conveyor discharges up a flight conveyor to a barge, which is then towed by a tractor to the washing plant.

SOAP MAKING

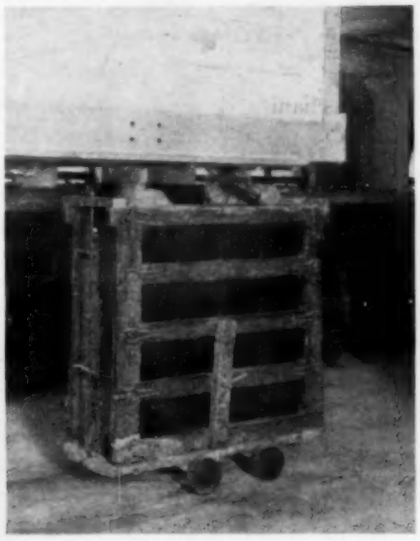


Emphasizes Supplementary Conveying

SINCE the actual manufacture of soap is a process of few distinct stages, it may appear natural that improvements in handling have concerned mainly the steps both before and after the strictly "soap-making" procedure involved. Thus, in its path from the kettles to the dried bars, the product is handled in a well-defined routine that has grown up with the industry; while the preliminary flow of raw materials and the later packaging offer a greater opportunity for special methods.

Removing Sides of Frame From Cake Prior to Slabbing

In general, the fatty material for hard soaps arrives in drums, tank cars, or by water. Depending on whether the fat is solid or liquid, it is immediately pumped to storage, with or without the aid of steam. Long pipe lines, out in the open, have an insulating and steam-jacketed covering to insure free flow; indoors this is rarely necessary, because of the warmth of the building anyway and the shortness of lines. One arrangement for evacuating drums disposes of pump lines: On a floor above the storage tanks, steam is blown into the drums and the mixture flows in channels on the floor to an outlet leading to settling tanks below, from which the clear fatty material is run to storage. The further flow of fats to the soap kettles also is a matter of pump lines.

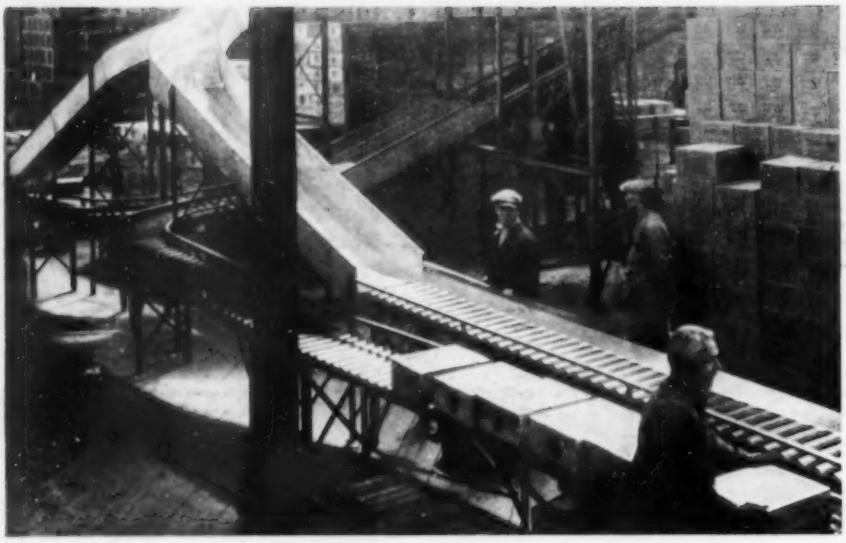


Filling Frame by Gravity From Crutchers and Kettles Above

Caustic usually is obtained in tank cars and pumped to storage, while other ingredients, such as borax and soda ash, arrive in bags and barrels. These are conveyed by hand trucks and lifts to storage or directly to the point in the process where they will be used. As in the case of the fatty materials, the properly diluted alkaline reagents are pumped to the kettles.

The reaction mass resulting from saponification also depends on pumping for disposal to its several destinations. The actual soap, separated from glycerine by treatment with salt, is again pumped to storage or is conducted warm (usually by gravity

Slabs of Soap Being Cut to Bars and Returned in Layers to Original Trucks



Typical Installation of Rollers, Chutes and Belt Conveyors in Packaging Department of a Soap Plant

flow) first to crutchers for aeration or admixture, and subsequently to the frames.

The traditional frame is merely a truck with removable iron sides, in which the soap is aged for, roughly, 10 days before the sides are removed from the now solid, rolling cake. This cake is then pushed by hand to the wire cutting machines and, after the necessary horizontal and vertical cuts have produced small cakes of desired size, the latter are conveyed on wooden racks, still on flat trucks, to drying chambers, where they remain for a half day.

Before the final stage, packaging, is discussed, mention may be made of variations not met in ordinary laundry soap. Chip soaps and toilet soaps dispense with the frame by passing directly from the crutchers to chip rolls, whence they are scraped off in ribbons and pass through heated dryers. Toilet soaps are then extruded through dies, cut to size, and travel on canvas belts directly to the packaging. Soap powder is scraped in thin layers from chilled rolls, and powdered soap is fluffed up by exposure to dry heat.

Packaging, while it entails most of the mechanical conveying in a soap plant, is almost wholly a matter of standard methods and equipment. Roller conveyors perform most of the handling between different machines, while between various packaging units there is frequent use of belts. After the soap has been inclosed in wrappers or containers and properly labeled, it is packed in fiber boxes. These are sent on by gravity roller and belt conveyors to the shipping room, where trucks and, usually, box cars are ready to carry them off.

The point where mechanization ostensibly could be advantageous is in the step from frames to packaging. Operating men have considered the matter for a long time, but the special nature of the product has made the conventional method still the most effective. Perhaps the solution will be some horizontal frame on a belt which will deliver the large cakes directly to the cutters, whence additional belts will carry them through the dryers, much in the manner of glass lehrs.

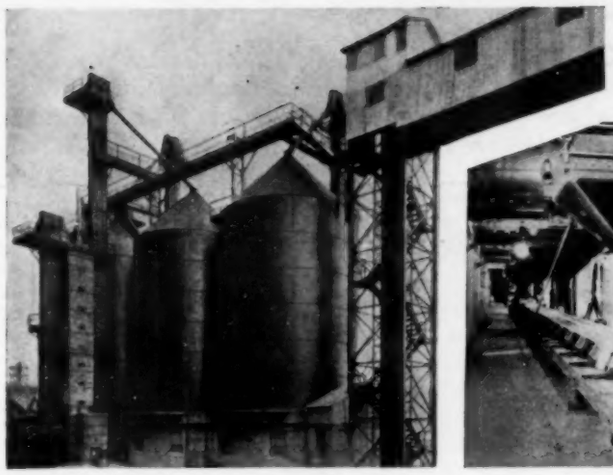
GLASS BOTTLES as a Product of Material Flow

ALTHOUGH the manufacture of glass into bottles, with its attendant conveying operations, usually is a matter of a few standardized alternatives, an inspection of a typical plant will give some indication of the variations and improvements possible where an alert management is attentive to its own special conditions. The example chosen for this brief consideration is the plant of the Owens-Illinois Glass Company at Bridgeton, to whose manager, J. B. Hayes, *Chem. & Met.* is indebted for his ready co-operation. The flow-diagram, given in the accompanying drawing, will show the general course of materials through this plant.

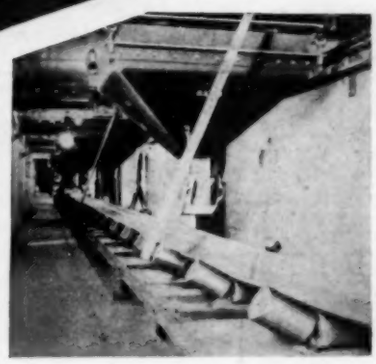
Silica is obtained as clean sand from near by and arrives in box cars kept in careful repair and lined with paper. These precautions are so necessary that even in favorable cases tiny cracks and holes give ready egress to fine streams of sand. The cars are promptly rolled alongside the silo storage house and evacuated into it with buckets that are dragged by a chain to the door. They dump directly on a grate at the threshold, whence the sand flows to a vertical bucket conveyor which hoists it to the silos above. The soda and lime arrive in bulk and likewise are hoisted to storage in silo bins.

Mixer Car Used in Some Plants for Gathering Materials From Silos and Discharging to Elevator

Located at a focal point under the silo bins is a scale hopper, into which



Storage Silos in a Glass Plant With Mixed Batch Elevator and Belt Conveyor Bridge at Right



Below—Belt and Scale Hoppers Under Silos

these raw materials flow by gravity, controlled by a weigh-master, with a series of air-operated valves on the various chutes. When a complete batch is accumulated, weighing about 4,000 lb., it is automatically dumped into a mixer directly below the scale hopper, whence it proceeds by conveyor belt and bucket elevator to the mixed batch storage bins into the furnace house.

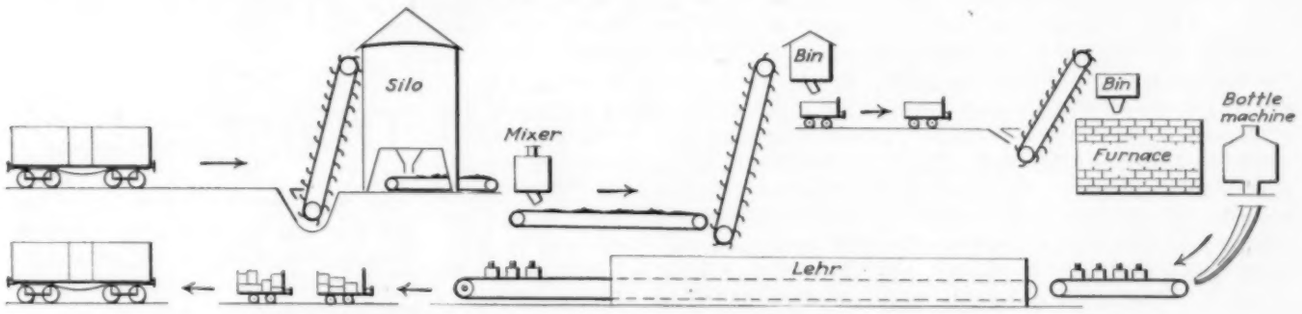
Producer gas fires the furnaces at this plant. The coal released through the bottom of railroad cars is hauled by an incline apron conveyor to storage bins, whence it goes by chutes to the gas producers below. However, a three weeks' supply is kept on hand in the yard and an electrically operated drag scraper brings it from storage pile to the railroad track hopper, when no cars are on hand to be unloaded.

Meanwhile, the mixed batch arrives in elevated storage bins in the furnace house, from which it is fed through chutes to electric cars and distributed to the various furnaces. At the end of each furnace, it is discharged into a floor hopper and elevated to a furnace-charging bin, from where it flows to the furnace by gravity. Three hundred tons of this batch is used daily in five furnaces.

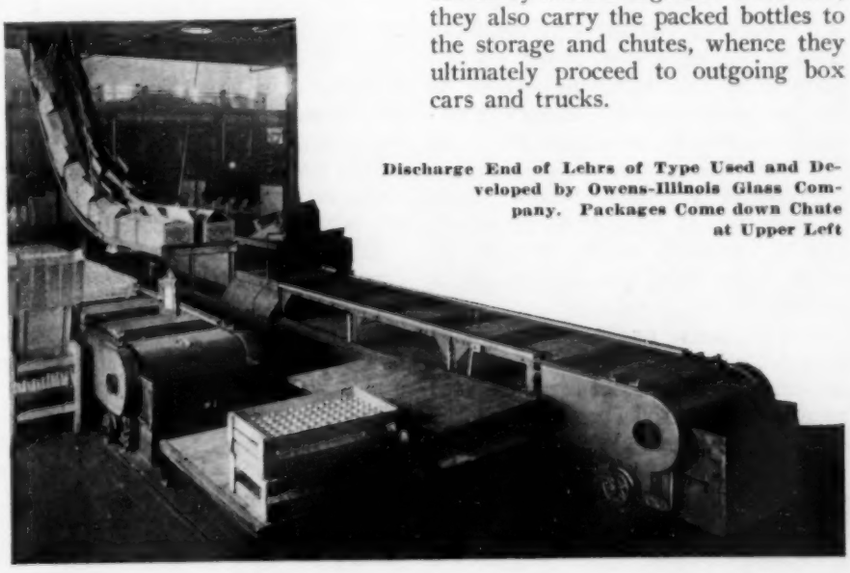
The molten glass is fed from the furnace to the machines by flow or suction, depending on the type of machine. As the hot bottles leave the machines, they are deposited on short conveyors which take them to the lehr. The handling from machine to lehr varies with the type of bottles. Except in cases of extra sizes and shapes, the machines place the bottles on the conveyor in upright position, and another machine called a lehr loader automatically places them in the lehr. When this procedure is not followed, the transfer is made by boys with tongs.

The unique type of lehr used here appears in the accompanying photograph. The annealing is done by electricity, with thermostatic control. This lehr was developed and patented by the Illinois Glass Company and is now in use in all Owens-Illinois Glass Company plants. The whole unit is mounted on wheels on a track and is moved closer to or farther away from the machine according to the product it happens to be forming.

The bottles, on leaving the lehr, are picked off for inspection and immediately packed in corrugated-board boxes that have been brought on trucks for the purpose. Since wooden and paperboard boxes are constructed on the premises, incidentally, transportation is involved on this end of the production too. Suffice it to say, however, that their construction itself involves only the normal gravity rollers and mechanical contrivances typical of packaging installations, while the necessary haulage is done by electric and hand trucks. The former are predominant, especially for heavy loads and greater distances; they also carry the packed bottles to the storage and chutes, whence they ultimately proceed to outgoing box cars and trucks.



Path of Materials in Plant of Owens-Illinois Glass Company at Bridgeton, N. J.



Discharge End of Lehrs of Type Used and Developed by Owens-Illinois Glass Company. Packages Come down Chute at Upper Left

Economy, Flexibility, and Quality

LITHOPONE'S Needs

In Handling Systems

By JOHN P. HUBBELL

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THREE FACTORS dictate the design and selection of the equipment used in handling materials in lithopone manufacture, viz: (1) the savings in cost; (2) the need for plant flexibility; and (3) the importance of maintaining a high quality product. The accompanying flow sheet shows the material which enters into lithopone production and the various steps in the processes of the barium, zinc, and lithopone departments.

About one ton of barytes is used for every ton of lithopone produced, and the proper handling and storing of barytes, therefore, represents the chief problem on the raw-material side. As received at the plant, this material usually is in the form of broken rock ranging in size from 8 to 10 in. down to fines. Since unevenly sized rock is difficult to handle, it is customary to pass the material, as soon as it is unloaded, into a jaw or gyratory crusher and reduce it all to minus 2-in. pieces. After rough crushing, the stone is either placed in storage or taken direct to the fine crushing plant.

IF imported barytes is used, even a small plant can afford a complete automatic handling system as far as the storage pile, since the material comes in shiploads of from 3,000 to 5,000 tons, which must be handled in a relatively short time. If domestic ore is used and shipments can be regulated closely to approximate daily uses, less equipment is justified.

Hand trams, or in larger plants wagon loaders and a motor truck or a locomotive crane and cars, are used to recover material from storage and put it into process. Where shipments come in regularly by rail, this extra handling is largely eliminated.

About 0.6 ton of coal per ton of lithopone is required for the barium furnaces. Half of this, approximately, is used for firing the furnaces and is replaced by oil in some plants. The other half is crushed and mixed with the barytes to form the charge. For firing, a good grade of high-volatile bituminous coal generally is used. Some furnaces have hand-fired grates and others are equipped with unit pulverizers and powdered-coal burners. In either case, adequate storage must be provided, and some means of bringing the coal from storage to the furnaces is necessary. In some plants the same coal used for firing is used also in the charge. In others, special mixtures are considered more economical. The storage and handling problems are simpler, of course, if the same coal is used. The charge coal is crushed to the same size as the ore. The same crushing equipment may be used.

FINE crushing practice varies considerably from plant to plant. In some cases the ore and coal are crushed on rolls to pass 4 mesh while in other plants Fuller Lehigh or similar mills are used to give a much finer charge.

After crushing, the ore and coal are placed in bins, from which they can be weighed accurately for charging into the rotary furnaces. Most plants use the Bruckner batch furnace, although continuous furnaces are becoming more numerous.

Black ash is discharged from the furnaces hot and is a dusty, disagreeable material to handle. It usually is conveyed as directly as possible to the leaching sysem, but some storage of black ash is necessary. Both pan conveyors and larry systems are used to take the black ash from the furnaces to the storage bins and from the bins to the leaching system.

Continuous counter-current leaching is now in general use, though batch leaching in rotaries and in lixiviation boxes is still practiced. Barium residues from the leaching system will run in dry weight to about 20 per cent of the weight of barytes charged. From continuous systems and from rotary batch dissolvers, the residues may be pumped as a slurry direct to the dump or run to settling pits, from which the mud is removed by grab buckets and trucked to the dump. "Lix" boxes usually are shoveled out by hand.

THERE are no unusual corrosion problems in the barium end of the plant. Most of the troubles come from barium crystallizing out, and this can be largely prevented by keeping everything as hot as possible. Wherever barium liquor is stored, a small quantity of mud settles, and this must be periodically cleaned out —another dirty job. In the furnace flues, dust collects which must be removed from time to time. This dust usually is recharged into the furnaces to recover its barium content.

Barytes, although somewhat heavier than ordinary rock, is not particularly difficult to crush, so that standard equipment for handling and crushing rock and ore is entirely suitable for this portion of the work. The only problem is to balance the equipment cost against labor cost in determining how much can be spent on the plant.

Roasted zinc ore or zinc-waste materials are used as a source of zinc. It takes about 22 lb. of zinc to make 100 lb. of lithopone. Most of the materials used will average approximately 60 per cent zinc, so that about 0.4 ton of zinc material must be handled per ton of lithopone.

Zinc materials usually can be purchased, so that the delivery is fairly regular. They are the most expensive raw material and, since large tonnages need not be handled at one

time, the unloading and storing equipment usually is designed more to prevent loss than to reduce handling labor to a minimum. This is especially so when waste-zinc products are used, since shipments from various sources are liable to vary considerably in zinc content as well as in impurities, so that it is desirable to keep them separate. Therefore, no general handling system is feasible. Where ore is the raw material and where it is purchased largely from a single source, it probably pays to invest in handling equipment.

WET crude lithopone from the filter presses is loaded on trays which are placed immediately on dry-room trucks. Highest grade crude filters with difficulty and is corrosive enough to be easily stained by most metal surfaces.

From this point on one of the major conditions which must be considered in designing handling equipment is to prevent the lithopone from becoming contaminated either by dirt, dust or splinters, or by coming in contact when wet with corrodible metal surfaces.

The dry crude is dumped from the drying trays and taken direct to the muffles. Two types of muffles are in general use. Where vertical muffles are used, it is necessary to elevate the material to the top of the muffle and to feed it into the muffle hoppers. A limited amount of storage is desirable at this point. Where rotary furnaces are used, the material may be dumped directly from the dry-room tray into the muffle hoppers or the trays may be dumped at a central point and the product conveyed to the muffles. In either case it is desirable to prevent the formation of fines and to keep the dried material as nearly as possible in the form of uniformly sized lumps.

About half a ton of 50-deg. Bé. sulphuric acid is required per ton of lithopone. Storage tanks, pumps, and pipe lines which are resistant to weak sulphuric acid must be provided if weak acid is purchased. The conventional lead-lined equipment generally is used in this case. Many plants purchase strong acid, and store and handle it in iron equipment.

Residues from the zinc-leaching tanks are relatively small in tonnage and usually are shoveled out of the tanks and trucked to the dump. The same general methods are used to handle the iron-press cake from the first step in the purification. The so-called cadmium residues which result from the purification of the solution by metallic zinc are generally saved and sold for their cadmium content. Their relatively small tonnage makes it unnecessary to have any special handling equipment.

FROM the muffles the product is dropped into water. The slurry may be handled in tubs or pumped directly to the wet mills.

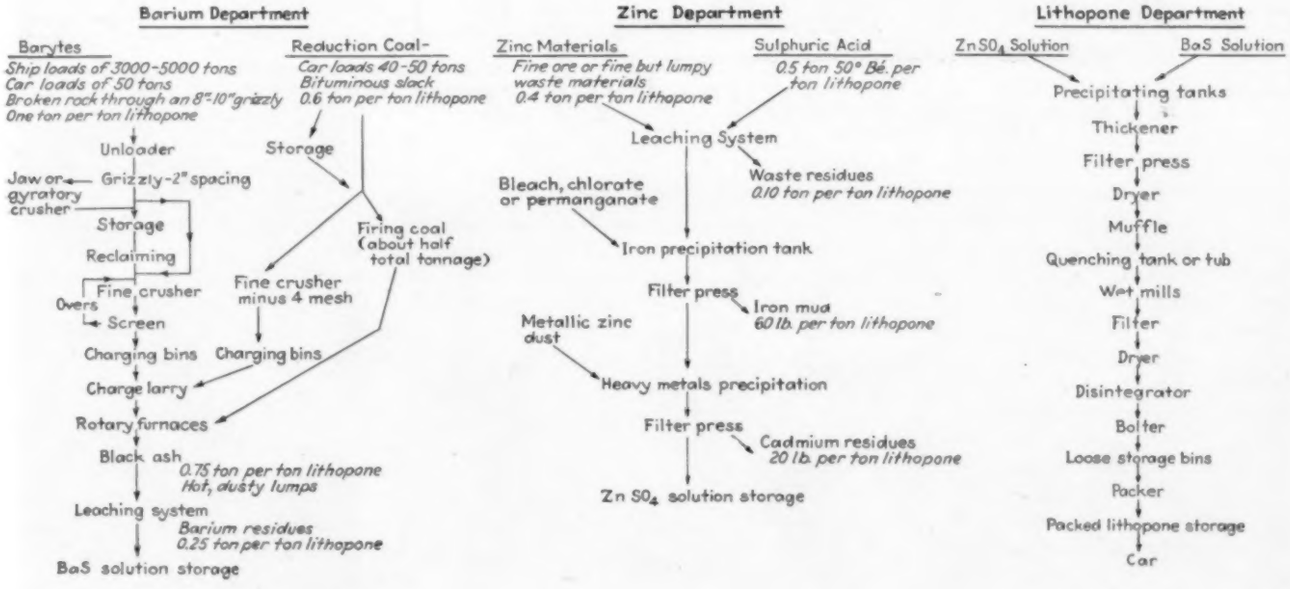
Finished lithopone filters much more easily than crude, and in many plants the combination of a continuous filter and a festoon dryer is used, although some plants still use filter presses and tunnel dryers. In these plants the filter cake is loaded by hand in the same way as the crude.

The dry product is disintegrated in Raymond mills or squirrel-cage disintegrators, bolted, and packed in standard packing machines. Practically all lithopone now is shipped in paper bags, although barrels are used in some special cases. Dry lithopone is dusty; therefore, all conveying systems must be tight. Dusting represents a direct loss of product. With the present high standards, sweepings cannot be mixed with the regular brands. Particular care should be taken to make this part of the system rugged, since loose iron or splinters in the finished package are objectionable and are certain to result in complaints and lowered prestige.

ADEQUATE storerooms for the packages are needed. Paper bags, though fairly rugged, must be handled with some care if they are to make a good appearance when they arrive at the customer's plant. Lift trucks and platform trucks are used in stacking and loading the bags and barrels.

A single type of lithopone can no longer be made to fill all requirements. Most producers make at least three different types and some as many as ten. As a rule, the same equipment can be used for making each brand, but where the demand is fairly steady, it is usually better to split the production. In any case, flexibility is important and to a large extent governs the design of the handling system in the lithopone department.

Flow Sheet of Lithopone Plant



Automatic Equipment and Gravity Serve a PAINT Plant

IN THE Newark (N. J.) plant of the Benjamin Moore Paint Company, straight-line flow and automatic handling of materials through the plant has been emphasized and, together with the carefully planned co-ordination and succeeding process operation, leaves little to be desired in the way of organization. These features have made possible an unusually large production for the available floor space. A group of three buildings, of modern fireproof construction, make up the plant. They are well lighted and ventilated.

A three-story manufacturing building and the solid raw-material storage building are separated by the shipping and receiving tracks. The oil and solvent storage building also adjoins the manufacturing building and is conveniently located in respect to the receiving tracks. Oils and volatile solvents are received in tank cars, carrying approximately 10,000 gal. These liquid raw materials are pumped from the cars to the storage tanks, holding 15,000 gal., and as required are pumped up to the 500-gal. tanks in the penthouse located on the roof of the manufacturing building.

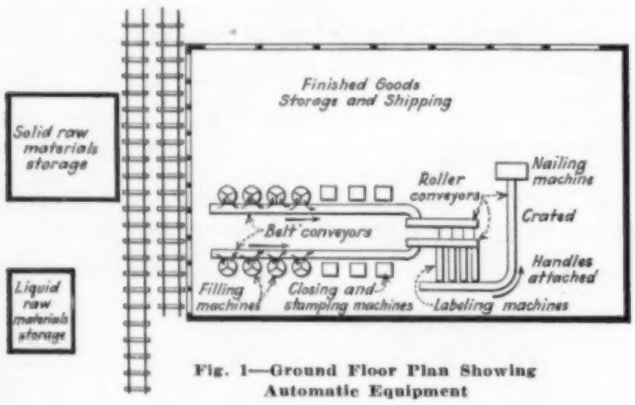


Fig. 1—Ground Floor Plan Showing Automatic Equipment

Lithopone, zinc oxide, lead carbonate, and other raw materials are received in carload shipments, in barrels, sacks, and other types of small containers. They are transferred from the railroad cars to the storage building on trucks. Each morning a day's supply of these materials is carried to the top floor of the manufacturing building by a Logan heavy-duty apron conveyor, designed to carry barrels, or bags.

From the very beginning to the end of the process of producing the paint, gravity is the only means of conveying required. The workmen merely open valves, and gravity does the work of transferring the material from one piece of equipment to the next. Containers of lithopone and other solid materials are emptied into the Kent or Ross mixers, located on the third floor of the building, and the oil is allowed to flow in at the same time. The oils and solvents, coming from the tanks in the penthouse above, are measured in calibrated tanks of 100-gal. capacity, before being allowed to flow into the mixing machines. After the mixing operation is completed, the mass flows down into the coolers, attached to the ceiling of the floor below, and from the coolers the paint flows slowly down into the stone mills directly below. These mills grind either singly or in tandem, the latter arrangement being used for difficultly ground pigments.

From the mills the paint flows into wheel tanks, where the shading is done. Careful mechanical agitation is necessary during the process of shading to effect proper mixing. For this purpose the wheel tank is pushed under the Ross upright column mixer and the electrically driven stirring device is lowered into the tank. After the shading is completed, the tank is moved directly over an opening in the floor and a valve in the bottom of the tank is opened, permitting the shaded material to pass into the agitating strainer.

From the strainers, it flows into the automatic filling equipment, and thereafter the plant is handled entirely by automatic equipment. Empty cans move along the belt conveyor to the automatic filling machines, which were built on specification by the Elgin Manufacturing Company. The plunger-principle filler was found after careful investigation to be best suited to the conditions in this plant. These machines can be easily adjusted so as to fill cans ranging in capacity from 1 gal. to ½ pint.

When the can is filled with paint it is returned by the machine to the belt conveyor, which carries it along to the point where it is shunted through an American Can Company covering and stamping machine. There are machines for three sizes in each unit.

After the cans have been properly covered they are returned to the belt conveyor and passed on to the Logan roller conveyor and through the Knapp or Burt labelers. Again a series of three machines is required to handle numerous sizes of containers. From these machines the cans pass on to another roller conveyor, the handles are attached, and the completed cans are packed into cases. This same conveyor moves the wooden cases along to the Morgan nailer. Completed cases of paint are then placed on platforms and carried by electric trucks to the shipping rooms.

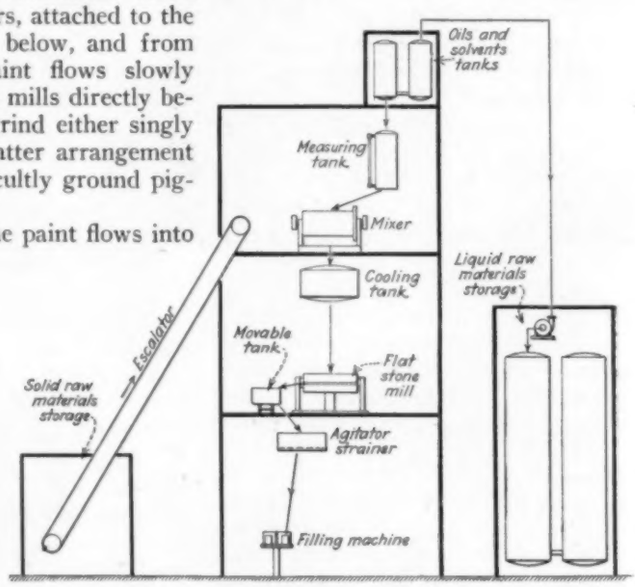


Fig. 2—Gravity Plays an Important Part in the Handling of Materials in a Paint Plant

Patterson pebble mills are used for grinding and mixing the enamel compounds. This process is very simple and is completed in one operation.

A feature of the Benjamin Moore Paint Company's plant is the equip-

ment for the production of the two or three colors of paint for which there is the largest demand. Dough mixers are used in conjunction with a Premier high-speed colloidal mill. Instead of using in this mill the customary stone surfaces for grinding, the friction surfaces have been cov-

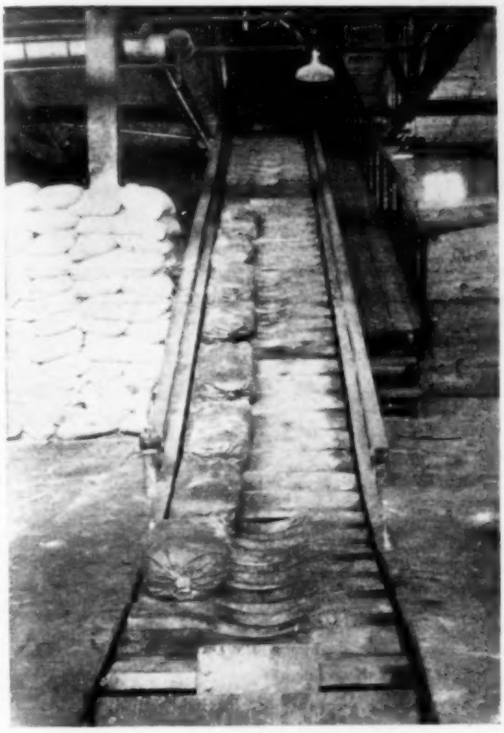


Fig. 3—Logan Apron Conveyor Carrying Raw Materials to Top Floor of Manufacturing Building

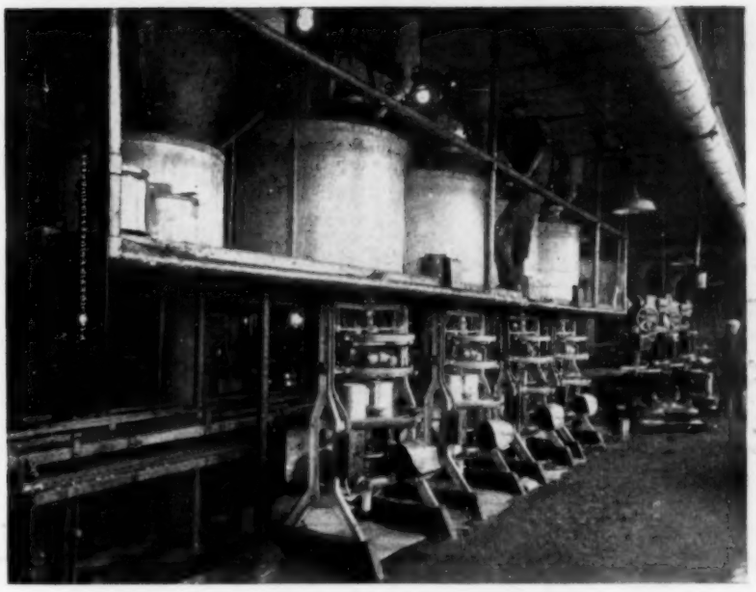


Fig 4—Belt Conveying Cans to Automatic Paint Filling and Covering Machines

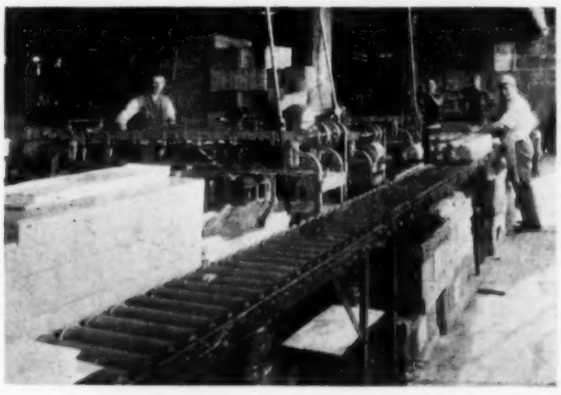
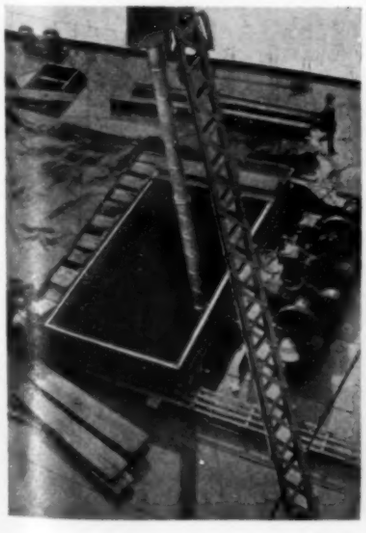


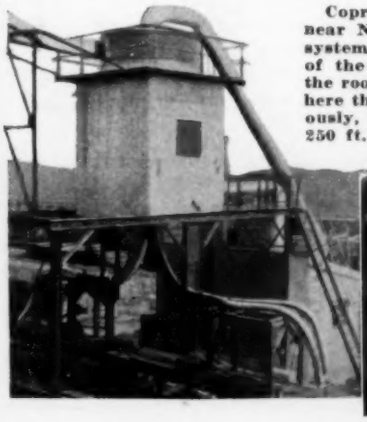
Fig. 5—Labeling Machines Put Cans on a Roller Conveyor. Workers Attach Handles and Pack the Cans in Boxes as They Move Along the Conveyor

ered with Stellite. This material has been found to give a longer life to the grinding surfaces and eliminates the necessity of closing down the mills for repairs as often as formerly.

The shipping room, located on the ground floor of the manufacturing building, is so arranged that seven freight cars can be simultaneously loaded along one side of the building while ten motor trucks are being loaded on an adjoining side.

Conveying COPRA From Boat to Cars





Copra is unloaded from ships at a large boat-rail terminal near New Orleans by means of a Holly pneumatic conveying system. The suction pipe (left view), dropping into the hold of the ship, handles pieces up to 6-in. size and passes over the roof of a building to the receiver in the center view. From here the copra is blown through pipes into two cars simultaneously, as shown below. Total length of the system is about 250 ft. and capacity over 100 tons per hour.

Belt Conveyor Housed in a Wooden Structure Is Used to Carry Waste Chips to the Cars

Ingenious Handling Equipment Used in PAPER Manufacture

By F. A. WESTBROOK
Consulting Engineer

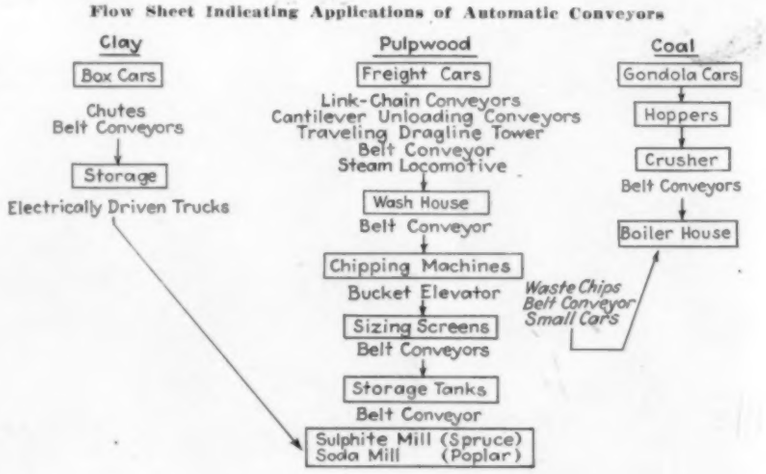
THE PAPER INDUSTRY has been very active in adopting and developing methods for the mechanical handling of materials in process of manufacture. In fact, the character of the processes lend themselves very well to mechanical handling, although some interesting special machinery has had to be devised, in some instances by company engineers and in other cases by manufacturers of handling equipment. The Cumberland mills of the S. D. Warren Company furnish a good example of the practical application of such equipment. It is an old established plant, several of the buildings having been in use for two generations. In spite of its age however, this plant has kept pace with industrial progress generally, and a record of the additions and changes in machinery would make an interesting historical recital of many types of improvement in manufacturing, applying to industry in general. The installation of up-to-date handling equipment has been one of these progressive steps and has been of great importance in operating economy.

Handling of the pulpwood, 4-ft. spruce and poplar logs, has called for a great deal of ingenuity. In addition, there is the handling of the clay used for making the coated paper, as well as a large tonnage of coal used in the power house.

Originally the water power available at this site was sufficient for the purposes of the mill, but now, in spite of extensive additional water-power developments at other points along the river, it is necessary to develop electric power by a steam-driven plant. About 300 tons of coal is used per day, so that its efficient handling is an item of real consequence. The coal is discharged from the gondola cars into hoppers located below the elevated track. From the hoppers it flows by gravity into the crusher and, again by gravity, to an inclined 18-in. belt conveyor, which carries it up to a similar horizontal conveyor, terminating at the boiler house. The crusher and two conveyors are driven by individual motors, each having push button controls at three points along the line of travel, so that one man can supervise the operations of crushing and transportation from freight car hopper to boiler.

Clay used in making the coated paper is imported from England and is unloaded from steamers at Portland. Due to the fact that it is imported and therefore subject to possible delays and, also, because a shortage in this raw material would be as serious as a shortage in pulpwood, considerable quantities are kept on hand. It is necessary to ship it in box cars from the boat to the mill, although a distance of only four miles, because it must be kept dry. Because of the plastic character of the clay, it has been found most convenient to remove it from the box cars in wheelbarrows which are emptied into chutes

Flow Sheet Indicating Applications of Automatic Conveyors



conveniently located along the receiving platform. These chutes discharge on 18-in. belt conveyors, 300 ft. between centers, of which there are two, extending the length of the storage space. The clay is dropped where desired by means of trippers and is delivered from storage to various parts of the plant by electrically driven industrial trucks.

Of course, the spruce and "pople" logs used for pulpwood constitute by far the greatest bulk of the raw materials, and the machinery provided for this purpose is both ingenious and interesting. The spruce logs are used in the sulphite mill and the poplar log in the soda mill. Consequently, there are separate storage piles in different parts of the plant. Spruce logs are unloaded from freight cars onto a 400-ft. link-chain conveyor, which leads directly to the wash house. After inspecting, sawing out knots, shaving off discolored sections, and washing, the logs are carried on another conveyor to the chipping machines. Waste shavings are carried outside on a small belt conveyor, from which they are dumped into small cars, and taken to the boiler house.

The chipping machines are located in the basement of the wash house. The chips are conveyed from them to the sizing screens, a height of 30 ft., by a bucket elevator. From this point the chips are carried on an 18-in. belt conveyor, 300 ft. between centers and inclined at an angle of about 30 deg., to the top of the storage tanks. Another horizontal conveyor extends across the tops of these tanks and distributes the chips as desired.

FOR transportation of the "pople" logs, more elaborate equipment has been installed and will later be applied to the spruce logs. Freight cars carrying the "pople" logs are run on to a siding, long enough for about eight cars. The logs are thrown off the cars, by hand, onto a link-chain conveyor, about 200 ft. long, along one side of the tracks. This conveyor delivers the logs to another conveyor which stacks them into large piles. The latter conveyor consists of a fabricated steel cantilever beam 125 ft. in length rising some 90 ft. above ground and equipped with a link-chain conveyor. This entire machine travels along rails on its own power, so that a number of large piles may be made by it.

On the opposite side of the piles from the freight car siding is the track for the traveling dragline tower, by means of which logs are mechanically pulled from under the upper end of the cantilever unloading conveyor so as to elongate the base of the piles and make them larger. In addition, the dragline pulls logs directly off the piles to a conveyor extending along the ground across the ends of the piles and leading to the mill. The logs are thrown on the conveyor by hand. As it is necessary to have storage piles in other more distant parts of the plant, there are tracks from those points to the conveyor leading to the soda-mill wash house, over which the logs are hauled on flat cars by steam locomotives.

The conveyor from the storage piles runs up an incline to the wash house. After washing, of course, comes the chipping. In this case the chips are delivered to the storage tanks entirely by 18-in. belt conveyors. On account of the height to which the chips have to be elevated and the comparatively short horizontal separation of the respective buildings, the conveyor system has been ingeniously arranged in three zigzag sections, on the principle of a switch-back railroad. At the top there is a fourth section for distributing the chips to the various storage tanks.

Overhead Handling Helps Turn HIDES to LEATHER

By WALTER P. CAHILL

General Superintendent, Graton & Knight Company
Worcester, Mass.

GREEN HIDES are the basic raw material used to produce the belting, sole leather, welting and other leather products of the Graton & Knight Company. Hides are bought in the green-salted condition from domestic packers as well as some European countries and South America.

Shipments are received in carload lots and placed on a siding situated outside of the hide cellar in which the hides are to be stored until required for processing. The unloading is accomplished by throwing the hides on a conveyor which automatically counts and weighs the shipment and distributes it to sections in the hide shed, where the hides are then salted down in packs for preservation until required for tanning.

In the beam house, which is immediately adjacent to the hide storage, as shown on the flow chart, Fig. 1, the hides are prepared for tanning. It is first necessary to remove the hair, dirt, and loose flesh, and to wash the hides thoroughly in order that well-tanned leather may be made.

Delivery of the hides to the beam house is made on a platform trolley suspended from an overhead track. As they are brought in, they are placed in a wash wheel and, after the necessary period of washing, are toggled together in lots and reeled into the first lime pit, where the hair is loosened. The pits are divided into sections, one lot of hides going into the first pit in each section daily and being moved from one pit to the next until the liming operation has been completed. Transferring of the hides is accomplished by means of an electrically operated reel shown in Fig. 2. This view shows workmen operating the reel so as to draw the hides from one pit and drop them into the next. The reel runs on tracks between the pits and may be moved sidewise to another row of pits by means of the transfer car in the foreground.

Lime is received in carload lots and is unloaded by use of an electrically operated shovel controlled by an operator who directs the lime onto a flight conveyor which carries it to the lime storage room. From here it is carried in buckets by means of an overhead trolley to the mixing tank and then piped to the different pits as required.

After the liming operation is completed the hides are reeled onto a platform which is then hoisted up by means of a chain fall suspended from an overhead trolley. The hides are moved to the unhairing machine, where the hair is removed, falling into a pit from which it is picked up by a conveyor and is carried into a

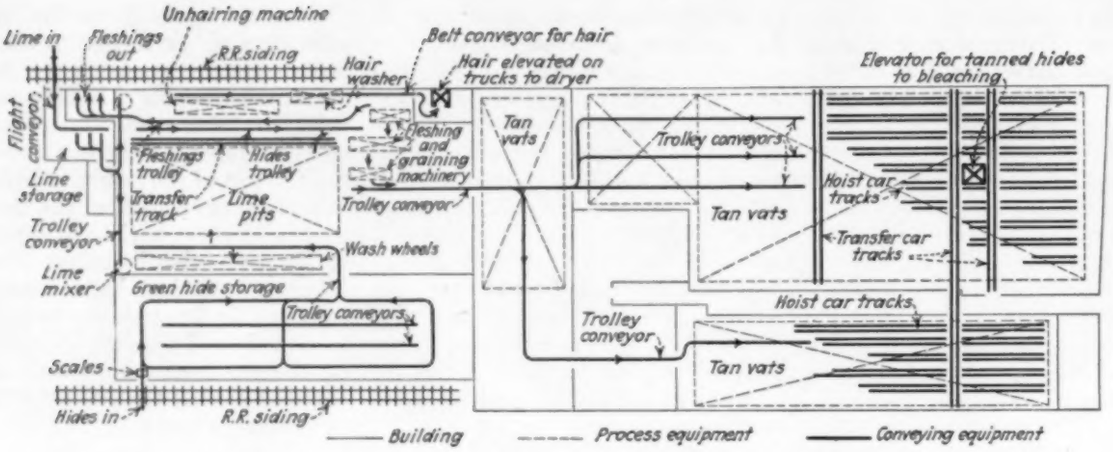


Fig. 1—Conventionalized Flow Diagram Based on Actual Location of Process and Materials Handling Equipment in Graton & Knight Company's Tannery

washing machine, where it is thoroughly cleansed.

In order that subsequent tanning operations may be effective, it is necessary that all loose flesh be removed to accomplish proper penetration of the tanning liquor. Fleshing is a machine operation, the fleshings falling into buckets placed in pits beneath these machines. When full, the buckets are picked up by chain falls suspended from an overhead trolley and delivered to the flesh storage for shipment.

The machines used in the final operations of the beam house are placed fairly close together and the movement of the hide lots is accomplished by hand truck. Delivery is then made to the tan yard by means of an overhead trolley system. In the yard the actual tanning process takes place. It is composed of hundreds of vats into which the hides are laid away for three to four months.

It is necessary to move the hides at various times, this operation being performed by means of an electrically operated hoist car, shown in Fig. 3. Hides are lowered into the vats on grids on which they remain so as to facilitate movement. Transfer tracks for the cars are placed at strategic points, permitting the hoist car to be moved to any part of the tan yard. When the hides are fully tanned they are delivered by means of the hoist car to an elevator located at the end of the tan yard and carried to the next floor for washing and bleaching.

Bleaching is performed by immersing the leather in different tubs containing acid, alkali, and water. To accomplish this the leather is suspended from an overhead conveyor which automatically moves to the various tanks into which the leather is to be lowered.

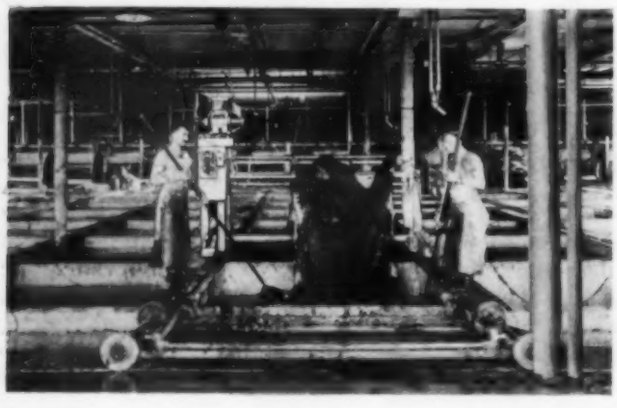
Drying is the final operation in tanning leather. The hides are placed in tunnel dryers in which the temperature and flow of air is controlled. They are suspended from a conveyor, which is moved daily until full drying has been accomplished, when delivery is made to the rough leather storeroom, where sorting and classifications are made. Operations from this point on consist in finishing the leather and in the manufacture of various leather products.

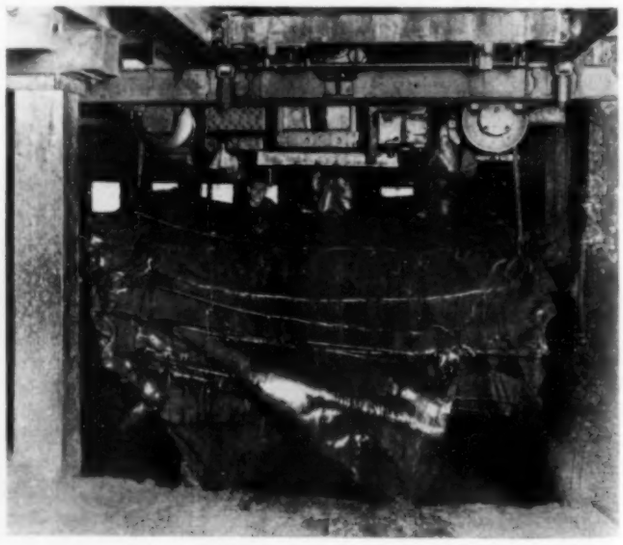
Hand trucking and handling have been entirely eliminated wherever it has been found economical to do so. By installation of labor-saving equipment it has been possible to reduce labor cost in the beam house and tannery at least 40 per cent.

In order to reduce labor cost and insure that installation of handling equipment will be economically made, there must be straight-line flow of product. In the tannery of the Graton & Knight Company, this has been accomplished and in no instance is there unnecessary retracing of steps that would make for uneconomical handling. While the ground plan has been simplified somewhat in preparing the flow diagram, so as to make it easier to follow, it nevertheless gives correctly the position of the various departments and equipment, and shows that compactness has been achieved. It shows also that straight-line flow of materials is in effect and is actually followed.

Fig. 2—Below: Electrically Operated Reel Transfers Strings of Hides Toggled Together From One Lime Pit to the Next; Note Transfer Car in Foreground

Fig. 3—At Right: Hoist Car With Load of Hides Lifted From Tan Vat, About to Be Moved on Transfer Car to Another Track





Handling HOT COKE in a City Gas Plant

By M. B. HILE

Superintendent, Prospect St. Plant
Citizens Gas Company, Indianapolis, Ind.

ONE of the most difficult jobs that a rubber belt can be called upon to handle is the conveying of hot coke from the wharf. It is the purpose of this article to describe a duplex belt system which had been in this service for more than two and one-half years at the Prospect Street plant of the Citizens Gas Company in Indianapolis.

Coke is pushed from the horizontal retorts of the ovens by means of a standard pusher and is caught upon a quenching car which carries a sloping steel deck. The coke is quenched with water and the car is moved into position alongside of the wharf where it is discharged down a sloping platform to the duplex conveyor belt.

This type of service is ordinarily performed by a rubber conveying belt of the usual kind. However, at this plant the ordinary belt was replaced in August, 1927, with a duplex belt made by the Boston Woven Hose & Rubber Company. This system makes use of a power belt running over the usual head and tail pulleys and a wear sheet or pad which lies upon the power belt and is carried with it through frictional engagement. Instead of passing over the same head and tail pulleys, however, the wear sheet is carried over two considerably smaller idler pulleys which are mounted on adjustable arms. Small radius pulleys can be used for the wear sheet because of its very flexible construction. Fig. 1 shows the tail pulley and the mounting of the idler.

Such a small size of head idler makes possible a very short drop for the coke as it leaves the belt and decreases breakage, an obvious advantage where the principal market is for metallurgical sizes. With the belt formerly used the drop was about 25 inches, and is now only about 9 inches. Just what reduction in breakage has resulted from the duplex belt is impossible to say, since two other drops were eliminated at the time this system was installed, but it is evident that the decrease has been considerable.

Fig. 2—Small-Diameter Head Pulley of Conveyor Looking Down on Grizzly; Note Short Drop From Belt to Chute

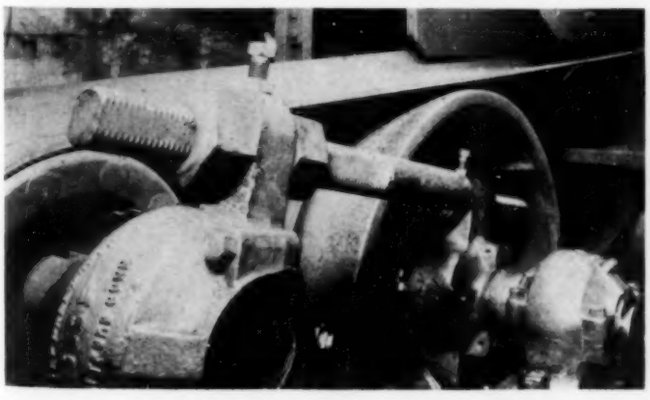


Fig. 1—Close-up View of Tail of Conveyor Showing Power Belt and Wear Sheet and Method of Supporting Wear Sheet Tail Pulley

Fig. 3—View of Boom Loader Just After Completing Filling of Car

Two belts that were previously used on this conveyor lasted respectively 10 months and 14½ months. Ordinarily, such belts would be expected to give a life of about 18 months apiece. The belt cost per ton of coke handled with old style belts was $0.009 in the first case and $0.0054 in the second. Last August the first wear sheet was removed, after service of 24½ months and after handling 535,117 tons. A new wear sheet was installed at that time over the old power belt and has since been in operation continuously. As it is impossible to predict accurately how long the power belt will last, any attempt to arrive now at the belt cost per ton of coke is very frankly an estimate. The actual cost of the first wear sheet alone was $0.00386 per ton. Assuming the life of the power belt to be respectively two, three and four times the wear sheet, we found total costs of $0.00557, $0.005 and $0.00472 per ton for both wear sheet and power belt.

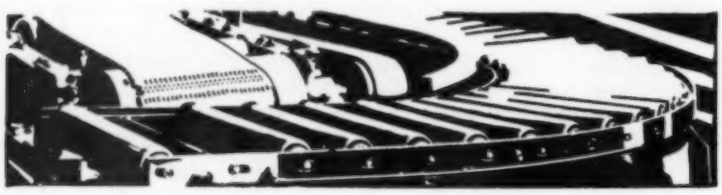
The chief importance of the duplex belt to us, however, lies in reduction of lost time due to repairs and in decreased coke breakage. Since an increased demand for metallurgical sizes had arisen at the time the belt was installed, this latter feature was very advantageous.

The duplex conveyor is 574 feet long and is carried on anti-friction troughing idlers spaced on 4-ft. centers. The transmission means is a 28-in., 6-ply, rubber-covered power belt. It passes over a 36-in. head and a 30-in. tail pulley and operates at a speed of 180 feet per minute. The wear sheet is of rubber specially compounded to withstand high temperature and is 36 inches wide and ⅜ inch thick, including two plies of duck. Its idlers are 12-in. pulleys.

The conveyor runs horizontal be-

neath the wharf for about one-half of its total length, and then on an 18-deg. incline to the grizzly. Skirt boards are provided on the horizontal run. Coke discharges over a roller-type grizzly, where the fines are separated for domestic sizes and the oversize passes over and down a brick-lined chute to a short cross-conveyor belt. This belt discharges to a boom loader, Fig. 3, which may be raised or lowered so as to give the shortest possible drop in loading the car.

When loading is in progress the man in charge of loading is in constant signal communication with the wharf operator. If the former anticipates need for stopping the coke flow, he signals the wharf to close the gate and thus prevent hot coke from lying on the belt while it is not in motion. As an additional precaution, and since fines may run through the wharf gate while it is closed, the belt is wet down at every stopping. Although small areas have sometimes been burned through carelessness on the part of the wharf man, such mishaps are not the result of normal operation.



Mechanical PACKAGING Of Chemical Products

By WILLIAM K. EMBLETON

Pneumatic Scale Corporation, Norfolk Downs, Mass.

MARVELS accomplished by the chemical engineer in producing and refining articles of every-day necessity would in a large measure be an effort wasted if mechanical engineering did not provide proper means to convey the finished chemical product to the consumer in packages small enough to be practical and place the products within the reach of all, and containers that would preserve and retain the chemical character of the products until the material had been consumed. Various types of protective packages have been devised. Materials not requiring a full measure of protection can be packed in an ordinary cardboard carton; others require a cardboard carton with an inner paper protection of either wax, glassine or other papers. Some products must be hermetically sealed in tin, and still others in glass.

Mechanical engineers have kept pace with chemists in providing not only proper protective packages for the products but also the machinery to handle the package mechanically, machines that practically eliminate any possibility of outside contamination. This automatic equipment produces packages rapidly and continuously, and in so doing insures the producer a minimum packaging cost and a standardization in the sizes of his packages, while providing him with a method to assure the consumer of a standard quality. Producers of products of high standards obtained very largely through chemical research are able to protect these high standards through the sale of the standardized package and its message carried on the outside wrappings.

Manufacturer, retailer, and consumer of innumerable sorts of necessities and conveniences of life (ranging from cooked foods to cosmetics) appreciate the fact that packages, cartons, and cans represent a necessity in merchandising. The problem of the engineer is to provide a mechanical unit to produce such packages automatically in a sanitary and efficient manner at low cost. American machine designers have developed and refined automatic machinery for packaging purposes to such an extent that today a machine is obtainable whether the packaging process follows standard practice or is of a special nature.

Inasmuch as automatic machinery must be considered in all packaging-production plans, careful attention to the preparation of the various component parts in the make-up of the package is a necessity. All materials entering into the make-up of the package should be planned and purchased with a view to efficient and economical handling by automatic machinery.

First of all, the type of package must be chosen from the standpoint of the degree of protection required for the product to be packaged in order to insure the product retaining, without change, the qualities developed in the product by the manufacturer. This does not necessarily mean that either the materials entering into the make-up of the package, the shapes of the packages, the qualities of the protective papers, or the labels should differ in any important manner from established commercial standards. It simply means that the materials entering into the make-up of the package and the manner of their use should be specified to embody certain necessary features.

When considering the use of automatic machinery producers of materials to be marketed in cartons need not hesitate for fear that the expense might be too great. The market offers inexpensive semi-automatic equipment, operating at comparatively low speeds, as well as highly specialized, fully automatic equipment capable of producing complete packages at the rate of 60 or more per minute. Machinery, whether small, inexpensive units or large units operating at high speeds, is designed so that packages can be produced more efficiently and economically than is possible by hand labor.

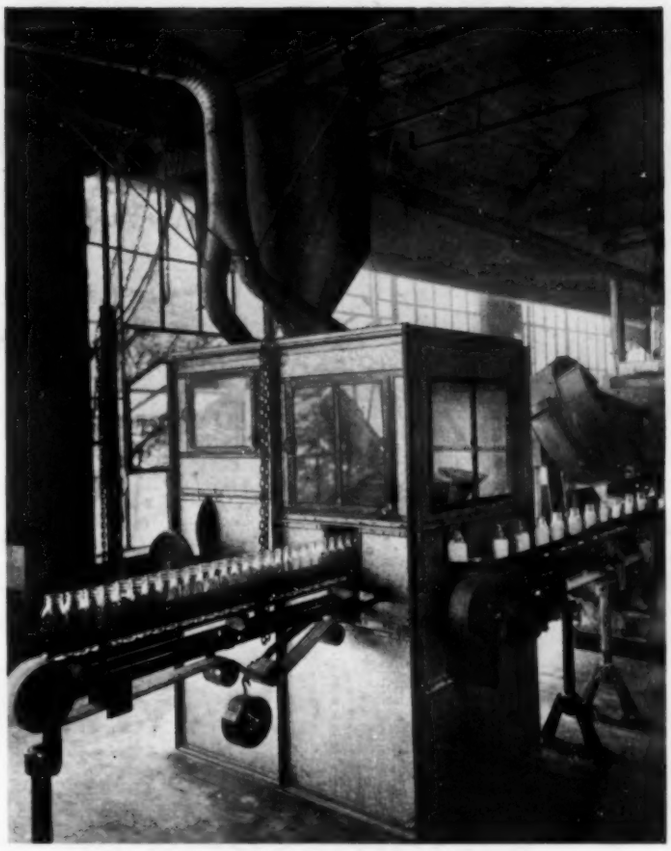
IN many instances the character of the product demands a container of greater strength and protective features superior to those of the ordinary cardboard carton. Machine designers have met these requirements with equipment which automatically produces a package in the same manner that the carton is produced. A wrapper is applied which adheres to every portion of the package, becoming an integral part of the package, and eliminating any possibility of deterioration of the product or dan-

ger of contamination from outside sources. This type of container is termed a "tight-wrapped" package.

Most automatic machines are so designed that they will handle several different kinds of materials and will be adjustable to several sizes of packages. Automatic equipment has been developed for pouring liquids into bottles, jars and other types of containers. This equipment affords a rapid and inexpensive method of packing the product in proper size containers for the convenience of the consumer. These machine methods of packaging liquids and semi-liquids began with the advent of the vacuum filling process, about 1916. Prior to the application of the vacuum principle of filling, rapid production and distribution were almost impossible.

With the advent of the modern vacuum-filling equipment, standard condiments, liquids, and semi-liquids, such as vinegar, mustard, olive oil, tomato catsup, mayonnaise and French dressing, syrups and numerous pharmaceutical articles were automatically poured into many types of glass containers. It is not uncommon in many finishing rooms to label the bottles and containers before they are passed through the filling and capping machines. Even ink bottles are labeled before being filled, without the slightest danger of labels being marred with the drippings from filling nozzles.

The vacuum system consists of a supply tank, placed below the level of the bottles to be filled, and connecting with the supply tank are the supply pipes or lines. A filling nozzle is attached to each line. An overflow receptacle is attached to the supply tank. The vacuum pump creates a vacuum in the overflow receptacle, which is airtight, and in turn creates a vacuum at the lower end of the air line, or suction end of the nozzle. Around the suction nozzle is a gasket. The bottle is brought in close contact with this gasket, making an airtight seal. Immediately a vacuum is created in the bottle, which puts a suction on the end of the liquid-supply nozzles, and this in turn draws the liquid from the supply tank up through the supply tube and into the bottle. When the liquid in the bottle reaches the end of the overflow, or suction line, it automatically breaks the vacuum, causing a cessation of flow of liquid into the bottle.

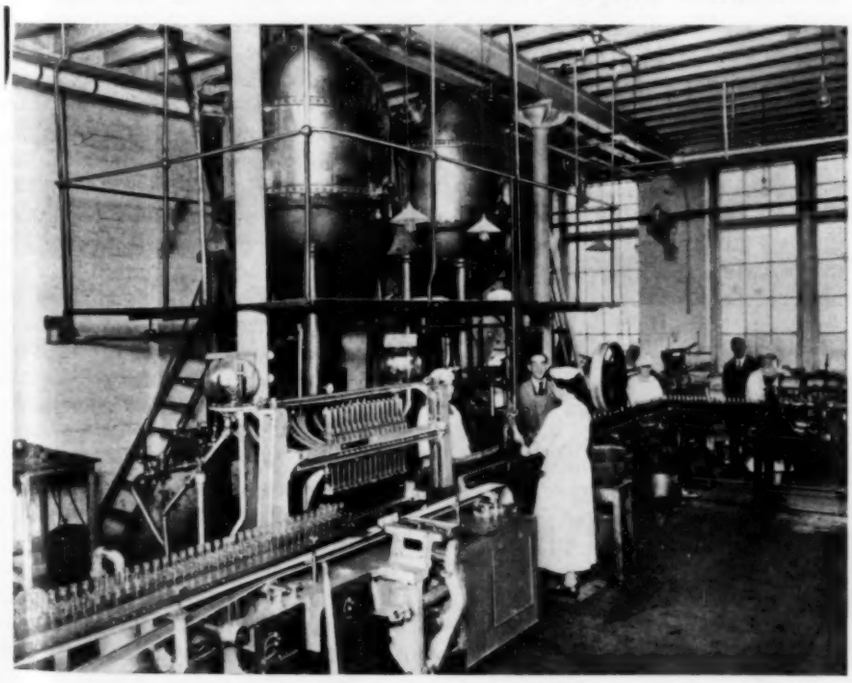


Vacuum Filling, Cap Feeding and Cap Applying Machinery in Plant of Upjohn Company, Kalamazoo

Perhaps one of the most ingenious types of filling machines is one which will automatically pour liquids into the modern all-glass sprinkler-top type, sometimes called the non-refillable. This machine will rapidly fill the bottle through apertures only $\frac{1}{16}$ in. in diameter, without even a drop of the liquid being spilled to mar the appearance of the bottle or the label.

A recent development of interest to the chemical industry is a machine which successfully forces lightweight, free-flowing, fluffy powders into bottles by vacuum. In many cases these powders can be packed more solidly by vacuum than by mechanical tamping.

American Equipment in Plant of Scottish Co-operative Wholesale Society, Glasgow



High Pressure Tank Cars of Barrett Company Hauling Anhydrous Ammonia

Interplant MOVEMENT Of MATERIALS

Requires Proper Shipping Containers

By BRONSON L. HUESTIS

Supervisor, Accident Department
Bureau of Explosives
New York City

CHEMICAL manufacturers may make large quantities of the best materials, to be used by others to prepare a wonderful variety of finished products, and these products may constitute a marked contribution to the common welfare, but in order that these three allied conditions shall go harmoniously together, we cannot overlook the importance of adequate packing and of proper handling while the raw materials are en route to the maker of the finished product and while the latter's output is on its way to the ultimate user. Not only must the material arrive in proper condition but its capacity, for causing property damage and personal injury must be held in check.

The so-called "dangerous materials" which may be shipped by freight or express are divided by the regulations of the Interstate Commerce Commission into general classes, as follows: Explosives, Flammable Liquids, Flammable Solids and Oxidizing Materials, Corrosive Liquids, Compressed Gases, and Poisons. Experience has shown the necessity for relatively stringent rules for packing and handling these materials, even to the extent of closely specifying the structural details of the inside and outside containers in which they are shipped. These rules, given in full in the Interstate Commerce Commission's Regulations for Safe Transportation of Explosives and Other Dangerous Articles, contain so much matter that only a guiding outline can be given in the space available for this article. Even so, it is worth while to explain briefly the basis on which the rules were formulated. It is human nature to feel greater enthusiasm for a set of rules if we realize that their foundation is rational instead of arbitrary. Although promulgated by a department of the federal government, the rules are largely the result of field research and years of practical experience on the part of the Bureau of Explosives, affiliated with the American Railway Association. Before any item was incorporated into the established rules, shippers, manufacturers or users of dangerous materials, and of containers for these products, were called into consultation and given an opportunity to contribute their own specialized knowledge. The resultant regulations thus summarized the experience of all concerned. Also, just as experience grows and conditions change, the regulations are subject to revision by the Commission to meet altered conditions, and even these revisions are made only after extended study followed by public hearings and discussion. Voluntary co-operation with a minimum of coercion is thus secured, because most of those concerned in obedience to the rules have collaborated in making them.

An outline of the subject can best be given by taking each of the six classes of dangerous materials separately, discussing briefly their principal hazards, the types and construction of containers authorized, methods of

marking, labeling, and certain specially required precautions.

Explosives—Everyone is aware that explosives should be handled carefully; but some are dangerous when subjected to shock, some to friction, and others to actual flame ignition. It is well to note before going further that there are explosives which *must not* be shipped at all by freight or express, such as liquid nitroglycerin, dry fulminates, fireworks or explosives containing an ammonium salt and a chlorate, and a number of other types possessed of abnormally great sensitivity. Among those explosives which can be lawfully shipped, we find sub-classes, such as high explosives (dynamites, picrates, trinitrotoluene, and dry nitrocellulose), low explosives (having characteristics similar to black powder), smokeless powders, ammunition of varying degrees of hazard, fireworks, and so on down to the relatively safe materials such as safety-fuse.

The containers used for high explosives are the I.C.C. 14 wooden box and the I.C.C. 10 wooden keg. It is impossible, in the space available, to give full constructional particulars of all the various I.C.C. containers, but it should be emphasized again that every shipper should give the most detailed attention to the requirements to be found in these container specifications.

With many commodities, it is necessary, before they are packed—even before they are made—to provide certain manufacturing requirements, in order to guard against decomposition, spontaneous heating, or other spoilage or fire hazard. For example, in the case of high explosives containing nitroglycerin, in addition to absorbent material of a quantity and kind sufficient to prevent leakage of the nitroglycerin, there must also be a satisfactory antacid.

For nitroglycerin explosives, a layer of sawdust or wood pulp must also be used in the bottom of the I.C.C. No. 14 box, and any vacant space left at the top also filled with sawdust or wood pulp. Empty boxes previously used for nitroglycerin, dynamite, or other explosives containing a liquid ingredient, are dangerous, and should be destroyed. Absorption of the liquid ingredient into the wood gives the empty box some of the hazard of the original explosive, and as it is often impossible to tell whether such absorption has occurred, the only safe procedure is to dispose of the box. In the same way, kegs that have been used for the shipment of any chlorate must not be used for shipping any other article.[1]

One of the most sensitive, and therefore dangerous types of explosive is fulminate, whether of mercury, silver, or other base. The shipment of mercury fulminate, for instance, is permitted only when it contains not less than 25 per cent of water. It is placed in a cotton cloth bag, with a cap of the same material over the fulminate inside the bag. The whole is securely tied, and placed in a strong grain bag, which is, in turn, tied firmly, and cushioned by a 3-in. layer of packed sawdust in the center of an I.C.C. No. 10 barrel. The barrel itself is lined with a heavy jute bag, sewed shut to prevent escape of sawdust. The barrel is then properly closed and tightened, and water poured in at the bung till the barrel is full, after which the bung is sealed. There must be no leakage of the water and the net amount of fulminate in the barrel must not exceed 150 lb. dry weight.

There are a number of other types of low explosives which lack of space prevents discussing more fully. Containers for these are mainly wooden and metal boxes, barrels, bags, and kegs, while black powder underlies various alternatives. The rigidity of the container requirements naturally decreases as the sensitivity or hazard of the explosive becomes less, extending downward to safety fuse, which may even be shipped in burlap-wrapped bales under certain conditions.

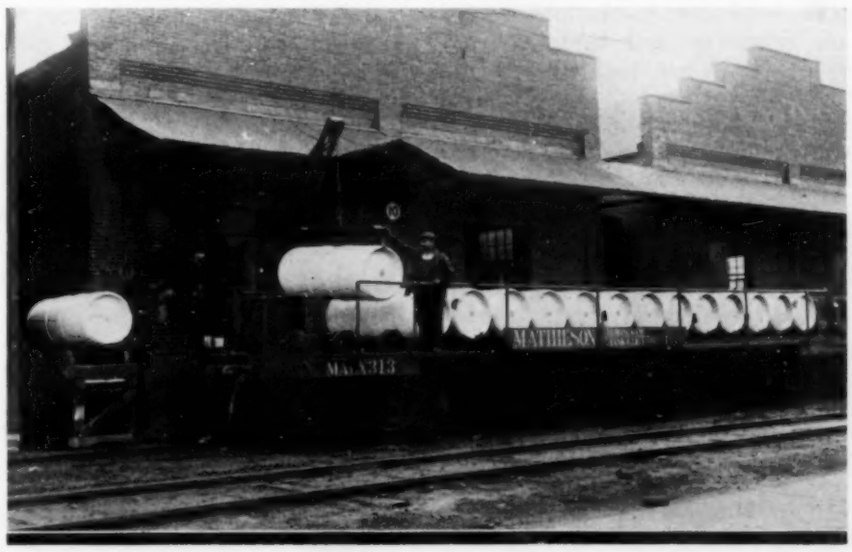
We come now to the dangerous articles other than explosives, which include the remaining five classes of material. It is impossible to go into detail for all these materials here, but two things may be accomplished; namely: (1) to touch the high lights of these dangerous articles and the containers required for them, and (2) to demonstrate the fact that the shipper who attempts to get along without a complete copy of the Interstate Commerce Commission's regulations, applicable to his particular products, is somewhat in the position of a blind man with one leg, walking a tight rope.

Flammable Liquids—This is by far the largest class of dangerous materials and the one that makes the most trouble. Though this is partly due to the enormous handling of gasoline, which runs over 12,000,000,000 gal. per year, there are, nevertheless, a great number of other liquids in this class—some of the greatest importance to chemical industry, such as alcohol, ether, acetone, and carbon bisulphide. Aside from sheer quantity, these liquids have a hazard which is different from that possessed by any other dangerous material: what might be called a "distance hazard." That is to say, ignition, sometimes with explosive violence, may occur at a considerable distance from the source of an original leakage, due to the spread of ignitible vapors.

It is of the utmost importance,

[1] If a package of high explosives shows excessive dampness or is moldy, or has outward signs of any oily stain, this may be due to leakage of liquid explosive ingredient. Unless the stain is definitely known to have been caused otherwise, or if there is any doubt as to the nature of the stain, the package must not be shipped.

Multiple Unit Tank Cars Being Loaded for Shipment of Liquid Chlorine by Mathieson Alkali Works



therefore, that containers for this class of liquids be as leakproof as possible, for if a leakage does occur, evaporation may prevent discovery of drip from the leakage, whereas a confined space, such as a box car or warehouse, may thereby become filled with explosive vapor. The consequences of ignition of such vapor may be out of all proportion to the value of the shipment of liquid. Someone recently figured out that the internal energy content of a gallon of gasoline is equivalent to that possessed by 96 lb. of 60 per cent dynamite! This does not mean that gasoline actually is as dangerous as dynamite, but it is dangerous enough without going into details, and other liquids of similar properties are scarcely safer.

Kegs of Black Powder Properly Packed in Box Cars for Shipment

There are about 25 different containers authorized under the I.C.C. regulations for flammable liquids, ranging all the way from boxed cans to tank cars. Many liquids may be shipped in any one of these types, but some of the more important and hazardous liquids are restricted to certain containers. For example, carbon bisulphide must be in metal cans packed in I.C.C. No. 2 wooden boxes (either glass, earthenware, or metal inside containers may be used if the quantity per inside container does not exceed ½ gal.), or in I.C.C. No. 5, metal barrels or drums not over 55 gal. capacity each, or in tank cars. For this purpose, a tank car is defined as a car having a tank or tanks mounted on or forming a part of the car. As there are several types of tank cars available, the type to be used for a given liquid will depend upon the vapor pressure of the liquid at 70 deg. F.

Certain types of containers are restricted to a particular maximum quantity of contents, both as to outside containers and to inside containers if any are used. In general, it should be noted that this applies to any kind of dangerous material of any class, and it should also be noted that the limits for freight shipments differ from those for express, the express limits being the lower. At present, as outside containers for flammable liquids, the regulations provide boxed carboys, two wooden boxes, several types of metal drums or barrels, several wooden barrels or kegs, both slack and tight, metal-jacketed cans, turned or plywood wooden drums, fiberboard or corrugated strawboard boxes, and tank cars. Among these containers are special ones for high or low flash-point liquids and for high viscosity liquids. An attempt was made to provide a safe container to meet every industrial need. As inside containers, we have available bottles, jugs, and cans of glass, earthenware or metal, and pails and kits.

Corrosives—For these materials we have boxed carboys, with bottles made of glass, also another type with lead bottles for materials, such as hydrofluoric acid, which attack glass; there are metal barrels or drums, tight wooden ones, wooden boxes, and slack barrels for inside containers, and also tank cars. For acids, the number of metal containers is not great, as so many corrosive liquids will attack metal, but for nitric acid, we find aluminum drums and also alloy steel drums (I.C.C. No. 5C). Concentrated sulphuric acid, of course, as well as nitrating acid (mixed nitric and sulphuric acids) and also alkaline liquids, may be shipped in steel drums and tank cars. For hydrochloric acid, steel tank cars with rubber linings may be used.

There is one rule concerning nitric acid which must be particularly observed. Containers of this acid must *not* be packed in the same outside container with any other article. Aside from the increased risk of leakage or breakage that would be produced, the records of the Bureau of Explosives appear to exhibit a peculiar fatality concerning such improper packing of nitric acid, for trouble always seems to follow.

Certain corrosive liquids must be packed with incombustible cushioning material, to avoid danger of fire in case of leakage. These are nitric acid, bromine, dimethyl sulphate, phosphorus trichloride, phosphorus oxychloride, and sulphur chloride.

Flammable Solids — This fourth class includes certain items which at first might appear as outside of chemical industry; for example, matches and charcoal. Others, such as metallic sodium or potassium, peroxides of sodium or barium, chromic acid, sodium picramate, benzoyl peroxide, phosphorus, and calcium phosphide, are all possessed of such chemical activity that, in the presence of some other substance, such as water or combustible material, fire or heating are certain or possible. The main point in packing such materials is to keep them from contact with whatever it is that renders them unstable. Here, hermetic sealing, or immersion in neutral substances, such as oil, or in the case of phosphorus, water, are called for.

There are many common oxidizing materials, such as nitrate of soda, that are dangerous only because of their ability to increase the intensity of a fire already existent in near-by combustible substances. By keeping such combustible materials, and also sources of fire, away, it is possible to ship some of these materials in bags or even in loose bulk. Chlorates, though possessing the oxidizing properties of nitrates, must be packed and handled more carefully, as they are sufficiently unstable to be decomposed by severe impact or friction, decomposition taking place at times with somewhat explosive violence.

Other flammable solids, such as charcoal and rubber scrap, may be susceptible to spontaneous heating;

while still others, like pyroxylin plastics, owe most of their hazard to a low ignition temperature and high combustibility.

Allowing for the difference between a liquid and a solid, the range of outside containers for flammable solids and oxidizing materials is somewhat similar to those for flammable liquids, except for the addition of types of lined wooden box, and the omission of tank cars and metal drums suitable only for liquids.

Compressed Gases—For the fifth class, compressed or liquefied gases, containers must not only be leakproof but must also be strong enough to withstand severe internal pressures. This limits the range of containers to steel cylinders and specially constructed tank cars. There are gas cylinder specifications to fit practically any commercially used pressures, and suited to the characteristics of all the common gases. One of the most interesting containers, and the only one specified for one kind of gas only, is the I.C.C. No. 8 cylinder for acetylene. If we apply very high pressures to acetylene, it will dissociate, with violently unpleasant consequences. The gas is, however, extremely soluble in certain liquids, such as acetone. We can dissolve, under a moderate pressure, as 250 lb. per square inch at 70 deg. F., a large volume of the gas, thus liquefying it without dangerous pressure. To prevent loss of the solvent, the cylinder is first filled with absorbent material.

For gases easily liquefied by pressure, such as chlorine and sulphur dioxide, the quantity of gas that may be charged into a given cylinder is specified as a proportion of the pounds water capacity of the cylinder. For instance, 1.25 lb. weight of liquefied chlorine can be put into an appropriate cylinder for every pound of water the cylinder could hold if filled with water.

As the ordinary tank car safety valve is set to blow at about 25 lb. pressure, it is easy to see that such cars are unsuited to the shipment of gases in profitable quantity. Consequently, the regulations provide for special cars which are either a series of small tanks or large cylinders cradled on a special car, or are single large tanks with very heavy shells and high-pressure fittings. There is one, for instance, having a shell at least $\frac{3}{4}$ in. thick, and tested up to 600 lb. per square inch pressure. Then, there is the special tank used by the U. S. Navy for shipping helium for its dirigibles. This tank may consist of an immense cylinder, forged hollow from a solid billet of steel, or forged solid and bored, like a big gun. These cylinders usually are mounted three to a car, each cylinder extending the full length of the car, with two on the floor and the third above. Obviously, a specially designed car is required, because the weight of these cylinders is enormous, as may be inferred from their test pressure of 3,350 lb. Experiments have been made also with welded tanks of spherical form for these high pressures.

Poisons—The sixth class may be divided into Class A, substances whose gas or vapor, mixed in very small proportion with air, is dangerous to life (e.g.: phosgene, chlorpicrin, etc.); Class B, poisons which are chiefly dangerous if taken internally; and Class C, "tear gas" materials. The aggregate volume of poisons shipped is less than that of other dangerous materials and therefore less trouble has been experienced with them. There is one feature that must be stressed, however: if leakage of a poisonous liquid, or sifting of a solid, occurs in a car, it may be small enough to go unnoticed, yet if foodstuffs or feeds are afterward loaded in the same car, serious consequences may result. The importance of tight packages for these materials cannot be overestimated. The regulations covering containers for poisons are exacting and extensive; too extensive to detail in this article. No one desiring to ship such materials should purchase containers or decide upon packing before consulting the regulations carefully.

There are additional features applicable to I.C.C. packing and containers generally. Every specification container must bear the proper specification number, in letters not less than $\frac{1}{2}$ in. high as: I.C.C.-14. On certain containers, this number is inclosed in a rectangle. Gas cylinders, in addition to the specification number, are marked with a serial number, the name or initials of the owner, and the date of manufacture, also dates of subsequent pressure tests. Metal drums or barrels must bear the specification number, the U. S. Standard gage number of the thinnest plate used in the drum, nominal capacity in gallons, year of manufacture and the name, initials, or symbol of the manufacture. Carboy boxes have, besides the I.C.C. number, the initials or symbol of the company applying the marking, and the month and year when the package was last cushioned, all this marking being in letters at least $\frac{3}{4}$ in. high, and cut or burned into the wood. Such packages are subject also to semi-annual tests on the so-called "Swing-tester" to determine the strength of the package and the effectiveness of cushioning.

Labeling—A series of labels is provided for all packages shipped under the I.C.C. regulations; for flammable liquids, a special red label; for explosives samples, and for fireworks, by express, special red labels; and another special red label for flammable gases; a green label for non-flammable gases; a yellow label for flammable solids; a black on white label for corrosive liquids; and a red on white label for poisons. These labels must be applied to each individual package, except in the case of an entire carload, loaded by one shipper, to be unloaded by one consignee. Here, the labels may be omitted, their place being taken by four placards applied to the outside of the car. These placards must be applied whether the car is wholly or only partly loaded with dangerous articles. The placards themselves read: "INFLAMMABLE," "CORROSIVE LIQUID," "COMPRESSED GAS," "POISON GAS," "POISONOUS," and "EXPLOSIVE," with additional warnings and instructions in smaller type.

In an article of this length, it has obviously been impossible to convey more than an idea of what is covered by some hundreds of pages of small type in the I.C.C. regulations. If, however, the reasonableness and importance of these regulations has been impressed, and the need for detailed study of them by any intending shipper of dangerous materials has been emphasized, the most will have been made of the present opportunity.

CHEMICAL ENGINEER'S BOOKSHELF

Handbook of Handling

MATERIAL HANDLING EQUIPMENT. By *Edward J. Tournier*. McGraw-Hill Book Company, Inc., New York, 1929. 6x9 inches, 371 pages. Price, $4.

Reviewed by
GRAHAM L. MONTGOMERY

ALTHOUGH the beginnings of mechanical handling of materials date back some thousands of years, it is only in very recent times that this manufacturing process has shown any advance sufficiently marked to gain separate attention. Consequently, technical literature is meager in its treatment of this subject and there are but few textbooks and reference works to which the engineer can turn for information on it. Mr. Tournier's work, therefore, is a welcome addition to recorded knowledge in this field.

The title of the work is an accurate description of its contents, for it deals with the equipment available for carrying out the unit process, rather than with the engineering principles upon which the process is based. However, by citing many cases from actual practice, the author indicates in a helpful way what some of these principles are and how they should be employed.

The scope of the work is more restricted than might be wished by the chemical engineer, as no great part of the book is devoted to the handling of materials from one operation to another in the manufacturing plant, which has become by far the most important phase of the subject in many process industries. Approximately half of the space is taken up with a helpful, illuminating discussion of the handling of bulk and raw materials. This part of the work will be most useful to the process field, for the chapters devoted to the handling of coal, ashes, coke, sand, gravel, and dry, granular matter are very thorough, and especially helpful to those whose problems include unloading, storage, and rehandling.

Chapters on the selection and purchase of materials handling equipment also are of much value, for they will enable the engineer who is not thoroughly familiar with the process to avoid many pitfalls; another concise and useful chapter is concerned with handling finished products. For the paper industry, a chapter devoted to the handling of pulpwood and chips is of interest.

Considered as a whole, this book represents a first-class empirical treatment; although it does not proceed from the rational or engineering standpoint, which the unit processes usually require, it is the best book available today on its subject, and as such will be useful to chemical engineers.

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Fluid Conveyance

A TREATISE ON CHEMICAL ENGINEERING APPLIED TO THE FLOW OF INDUSTRIAL GASES, STEAM, WATER AND LIQUID CHEMICALS, Including the Pneumatic Transport of Powders and Granulated Materials. By *Geoffrey Martin*. Crosby, Lockwood & Son, London, 1928; 447 pages.

Reviewed by THEODORE R. OLIVE

THIS BOOK has much to recommend it once the reader has recovered from the shock which will surely be induced by some of its peculiarities. For example, the conscientious student, on turning to the preface is confronted by the alarming quotation, "A painful work it is I'll assure you, and more than difficult . . ." Then, delving into the contents, he discovers that the author, for some obscure reason, has numbered his pages separately within each chapter, but not serially. Again after the British custom, the book weighs several pounds and is fully 2 in. thick —truly a weighty matter.

And yet, in spite of the volume's formidable features, the author has accomplished something that has not been done before. He has reduced the science of fluid flow and flow measurement to something approaching simplicity. Once the reader has overcome his initial panic, the future unfolds logically and with a minimum of effort—verily, a boon to the busy engineer, to whom the book has been addressed. At his finger tips the reader finds formulas, derived and illustrated simply with explanations of symbols adjacent and not buried, as is customary, some 50 pages ahead. He finds tables—68 of them, some new and some covering many pages —giving him properties of gases and liquids at great length and for many varying conditions. He finds explanation of a great diversity of flow-measuring devices; he learns to compute pressure losses and power requirements. Last but not least, he finds chapters on fall of solids through fluids, the basis of air separation, and pneumatic handling of materials. The author has kept his promise and has proved the subject to be, for all its clanking chains and spectral aspect, a time-and-money-saving tool well worth the small effort its understanding will exact.

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Cane-Sugar Chemistry

A HANDBOOK FOR CANE MANUFACTURERS AND THEIR CHEMISTS. By *G. L. Spencer* and *George P. Meade*. John Wiley & Sons Company, New York. 560 pages. Price, $6.

Reviewed by CHARLES E. COATES

IT IS not often that any handbook has a life of 40 years. This book, however, was born just 40 years ago and has been re-edited seven times. So necessary has it proved to be that its presence in every sugar laboratory is taken for granted. Much of this long life has been due to the excellent printing which the book has always had, and also to the fact that during his lifetime, Dr. Spencer was in the habit of issuing a new and revised edition whenever advances in knowledge of sugar chemistry made it necessary to do so. This seventh edition probably would have been issued several years ago had it not been for Dr. Spencer's death in 1925. As the demand for a new edition became more and more imperative, considerable difficulty was experienced in finding a man to do the work. The choice of George P. Meade has proved most fortunate.

The present edition shows a thorough knowledge of the literature and a very painstaking attention to detail. Each of the chapters has been rewritten, and several of the chapters are practically new. In all cases the additions have been judicially and admirably made, which has resulted in bringing the book up to date in a manner which is exceptionally adequate. For instance, all the new Spencer apparatus is diagrammed and

described; the dye-test method; the conductivity method for ash; the pH determination, and the various comparators; the determination of color by the various colorimeters—these are all described in sufficient detail for most practical purposes with references for the man who wishes a more detailed discussion.

Perhaps the most important part of Spencer has been the excellent set of tables at the end of the book. In this edition these tables have been revised and corrected according to the most recent publications. For instance, Table 14 is corrected to 1928.

Ordinarily it would be sufficient to say that this edition of Spencer is as good as the old Spencer. Mr. Meade, however, is to be congratulated upon making the last edition the best of all.

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The Citrus Industry

DERIVATI AGRUMARI: INDUSTRIA E COMMERCIO: Essenze, Citrato di Calcio, Acido Citrico. By *Carlo Rodano*. Ulrici Hoepli, Milano, 1930. 565 pages; 6½x9¼ in.

ITALY'S eminent position and national interest in the citrus industry underlies the preparation of this extensive volume, which includes in its scope, however, the outside countries that vie in importance, such as the United States, Spain and Japan. The whole work, in fact, is universally laid out: the opening sections present the general citrus situation, the long sections that follow go heavily into the technology involved in the production of all the citrus products (especially citric acid), and the concluding parts offer a résumé of the commercial outlook. Unexpected features such as conversion tables and the chapter on pectin, contribute to making the book a necessary consultant to those, at least, who are specifically interested.

* * *

Working Metal Powders

METALLKERAMIK: Die Herstellung von Metallkoerpern aus Metallpulvern. By *F. Skaupy*. Verlag Chemie, G.m.b.H., Berlin, 1930. 60 pages. Price, 6 M.

Reviewed by S. STREICHER

IN THIS treatise is extensively described for the first time a technique which has been developed within the last 25 years in connection with the tungsten lamp wire and which, about 70 years ago was used in making platinum ware. This is the preparation of metallic bodies by compressing and heating metal powders at temperatures below their melting point. The author shows how this technique can be used for the preparation of most metals; special examples given are tungsten, molybdenum, tantalum, osmium, iron (carbonyl-iron), tungsten-carbide (Widia, Carboloy). Other chapters give directions for the preparation of the finely divided metal powders, and methods for the determination of their particle size; the qualities of the metal bodies with and without a binder are analyzed. The publication represents a very desirable contribution to this old, but once forgotten, and now new subject.

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Living Reactions

OUTLINES OF BIOCHEMISTRY. By *Ross Aiken Gortner*. John Wiley & Sons Company, New York, 1929. 724 pages. Price, $6.

Reviewed by E. F. KOHMAN

THE first impression of the reader is that there is more of chemistry and physics than of biology. This characteristic is particularly pronounced in the early and best part which deals with physical relationships. We know of no more readable and informative material on colloidal phenomena than those first chapters.

Part II on Proteins is well gotten together but not particularly novel. This is no fault of the author, since protein chemistry has of late been quiescent. In Part III on Carbohydrates, after a brief respite, the author again finds his stride and from here on the food chemist will find much of value. Tannins, pigments, fats, liquids, essential oils, vitamins and enzymes are all ably treated. With the reference given, the chapters allotted to these are worth much to anyone working in any of these fields.

Certain passages must be read with discretion. These merely remind one that the author is not infallible, and hence very human. Taken as a whole, he deserves our heartfelt gratitude for making available so much material in such condensed form.

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MERCK'S INDEX: An Encyclopedia for the Chemist, Pharmacist, and Physician. Fourth Edition. Merck & Company, Inc., Rahway, N. J. 1930. 585 pages; 6x9¼ in. Price, $4.

To the man sensitive of his age it may be a shock to see how Merck's Index has grown since he knew it, but will be appeased to know that the growth occurred all in a sudden jump after two decades. Now it is a handsome large volume, listing all commercial chemicals (including, but in addition to, Merck's) and their technical properties. A volume not so much for the operating man as for the laboratory and purchasing department.

* * *

More Help for the Reading Engineer

IT WOULD have been surprising if the fad for Things-of-the-Month had failed to capitalize on the extraordinary necessity for selection in scientific fields, although the dangers and knowledge entailed may have acted as a natural restraint enough. However, the move has now been made and the Scientific Book Club, Inc., New York, undertakes to supply the judgment required for profitable scientific reading. Aware of the obligation identified with such a task, it apparently seems bent on fulfilling its commitments to its subscribers.

It functions much in the manner of most "selection services," that is, an editorial board chooses each month for its subscribers some book of eminent scientific merit (the first selection was "The Master of Destiny," by the neurologist, Frederick Tilney), but allows them a latitude of choice if they desire. Moreover, there is no obligation to take more than six books a year. The selections are to cover the complete field of scientific endeavor, including such subjects as astronomy, physics, chemistry, psychology, and geology. What is most imposing about the arrangement is the roster of names that will relieve the subscribers of an insuperable critical task. The authorities who comprise the editorial board are the Professors Compton, of Chicago; Thorndike, of Columbia; Mather, of Harvard; Stetson, of Ohio Wesleyan; and Conklin, of Princeton; while such names as Norris, Noyes, and Pupin appear on the advisory committee.

Although the project is aimed at a wide public it may perhaps find its best outlet among the scientifically trained, who are especially impatient of wasted time. The latter are most likely to value the high indorsement represented by the editorial board, while the Club's wide appeal should assure them of palatable reading. When thus doubly guarded against dull and futile fare, the engineer's native curiosity seems the chosen clientele for this commendable effort.

PATENTS ISSUED

March 4 to March 25, 1930

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Pulp, Paper, and Glass

Treating Residual Liquors Accruing from the Treatment of Cellulose Material. Pierre Alfred Barbou, Paris, France, assignor to Société Barbou & Cie., Paris, France.—1,749,557.

Laminated Glass and Method for Producing the Same. William E. Nobbe, Toledo, Ohio, assignor to Libbey-Owens Glass Company, Toledo, Ohio.—1,751,051-2.

Method of and Apparatus for Drying Wood Pulp and the Like. Richard D. Kehoe, New York, N. Y.—1,751,552.

Method and Apparatus for Producing Tubular Glass. Leonard D. Soubier, Toledo, Ohio, assignor to Owens-Illinois Glass Company, Toledo, Ohio.—1,750,971-3.

Method and Apparatus for Melting Glass and the Like. Robert L. Frink, Lancaster, Ohio.—1,751,987.

Rubber and Synthetic Plastics

Process for the Immediate Production of Mechanically-Unworked Pure Rubber Sheets from Latex. Paul Klein, Budapest, Hungary, assignor, by mesne assignments, to American Anode, Inc.—1,750,177.

Manufacture of Rubber. Ugo Pestalozza, Milan, Italy, assignor to Società Italiana Pirelli, Milan, Italy.—1,750,540.

Method for Treating Aqueous Dispersions of Rubber and Products Obtained Thereby. Merwyn C. Teague, Jackson Heights, N. Y., assignor to Naugatuck Chemical Company, Naugatuck, Conn.—1,750,767.

Resinous Condensation Product from Lignin and Furfural. Max Phillips, Evansville, Wis.—1,750,903.

Manufacture of a Solid Resin from the Semi-Fluid Resinous Matter Extracted from Crude Gutta-Percha and/or Balata. Alfred Brewerton Craven, Selby, England.—1,751,724.

Rubber Derivative and Method of Making Same. Webster N. Jones and Herbert A. Winkelmann, Akron, Ohio, assignors to B. F. Goodrich Company, New York, N. Y.—1,751,817.

Rubber Composition and Method of Producing the Same. Herbert A. Winkelmann, Akron, Ohio, assignor to B. F. Goodrich Company, New York, N. Y.—1,751,848.

Petroleum Refining and Products

Process of Purifying Hydrocarbons. John C. Black, Los Angeles, Calif., assignor, by mesne assignments, to Richfield Oil Company of California, Los Angeles, Calif.—1,749,240.

Vapor Phase Method of Oil Conversion. Cary R. Wagner, Chicago, Ill., assignor to Gyro Process Company, Detroit, Mich.—1,749,521.

Apparatus for Cracking Oils. William S. Hadaway, Jr., New Rochelle, N. Y., assignor, by mesne assignments, to Texas Company, New York, N. Y.—1,751,148.

Art of Continuous Distillation of Heavy Hydrocarbon Oils. Robert E. Wilson, Chicago, Ill., assignor to Standard Oil Company, Whiting, Ind.—1,751,182.

Apparatus for Treating Hydrocarbons. Gustav Egloff and Harry P. Benner, Chicago, Ill., assignors to Universal Oil Products Company, Chicago, Ill.—1,751,729-31.

Process and Apparatus for Treating and Purifying Hydrocarbon Oils. Lyman C. Huff, Chicago, Ill., assignor to Universal Oil Products Company, Chicago, Ill.—1,751,862.

Manufacture of Lubricating Oil. George H. Taber, Jr., Rye, N. Y., assignor to Sinclair Refining Company, New York, N. Y.—1,749,896.

Oil-Cracking Process. John B. Jaqua, Alhambra, Calif.—1,752,004.

Coal Processing and Products

Process of Coking. Harry G. Jennison and Charles R. Faben, Toledo, Ohio; said Faben assignor to said Jennison.—1,749,138.

Manufacture of Combustible Gas Containing Hydrogen and Carbon Monoxide. Gustav Wietzel, Ludwigshafen-on-the-Rhine, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany.—1,751,117.

Water-Gas Apparatus. Frank W. Steere, New York, N. Y., assignor, by mesne assignments, to Young-Whitwell Gas Process Company, Tacoma, Wash.—1,751,497.

Process of Making Uncarbureted Water Gas. Daniel J. Young, Tacoma, Wash., assignor to Young-Whitwell Gas Process Co., Tacoma, Wash.—1,751,502-3.

Gas-Making Process. Daniel J. Young, Tacoma, Wash., assignor to Young-Whitwell Gas Process Co., Tacoma, Wash.—1,751,849.

Back-Run Method of Operating Gas Plants. George E. Whitwell, Seattle, Wash., assignor to Young-Whitwell Gas Process Company, Tacoma, Wash.—1,752,223.

Gas Scrubber. William Alexander Skeen Calder, Ravensthorpe, Harborne, and William Harold Palmer, Smethwick, Birmingham, England.—1,752,260.

Gas Manufacture. Frank W. Steere, Highland Park, Mich., assignor, by mesne assignments, to Semet-Solvay Engineering Corporation, New York, N. Y.—1,752,278.

Organic Processes

Progress of Refining Edible Oils. Roger B. Hill, Berlin, N. H., assignor to Brown Company, Berlin, N. H.—1,749,976.

Process of Making Nitrated Sugar Explosives. Philip G. Wrightsman, Chester, Pa., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,750,948-9.

Manufacture of Dextrose. William B. Newkirk, Western Springs, Ill., assignor to International Patents Development Company, Wilmington, Del.—1,750,938-9.

Nitrated Carbohydrate Explosive and Process of Producing Same. Philip G. Wrightsman, Chester, Pa., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,751,063-4.

Process for Producing Anhydrous Alcohol. Ovidio Leonori, Narni, Italy.—1,751,211.

Process for Obtaining Thiocyanates of the Alkaline-Earth Metals. Robert R. Fulton, Wilkinsburg, Pa., assignor to Koppers Company.—1,751,274.

Nitrated Carbohydrate Explosive and Method of Producing the Same. Philip G. Wrightsman, Chester, Pa., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,751,377.

Blasting Explosive. Frank H. Bergeim, Woodbury, N. J., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,751,436-8.

Catalyst for the Production of Ethylene Glycols and Ethylene Hydrocarbons. Alexander T. Maximoff, New York, N. Y., assignor to Naugatuck Chemical Company, Naugatuck, Conn.—1,752,016.

Production of Halogen Substitution Products of Olefines. Charles O. Young, Charleston, W. Va., assignor to Carbide & Carbon Chemical Corporation.—1,752,049.

Non-Corrosive Alcoholic Solutions. William S. Calcott and Herbert W. Walker, Penns Grove, N. J., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del.—1,752,145.

Inorganic Processes

Utilization of Dolomite or Magnesian Limestone for Production of Metallic Magnesium, etc. Herbert H. Dow and Edwin O. Barstow, Midland, Mich., assignors to Dow Chemical Company, Midland, Mich.—1,749,210-1.

Ammonium-Nitrate Explosive and Process of Making It. Walter O. Snelling, Allentown, and Joseph A. Wyler, South Whitehall Township, Lehigh County, Pa., assignors to Trojan Powder Company, New York, N. Y.—1,749,613.

Manufacture of Anhydrous Magnesium Chloride. Karl Staib, Bitterfeld, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany.—1,749,854.

Method for Synthetically Producing Ammonia from Its Elements. Georg Friedrich Uhde, Bovinghausen, Germany.—1,750,551.

Process of Producing Elemental Sulphur. Raymond C. Benner, Bayside, and Alfred Paul Thompson, Jackson Heights, N. Y., assignors to General Chemical Company, New York, N. Y.—1,751,066-8.

Production of Alkali from Natural Brine. Ross Cummings, Berkeley, Calif., assignor to Robert D. Pike, Piedmont, Calif.—1,751,132.

Production of Basic Lead Chromate. Alexander Stewart, Roselle, N. J., assignor by mesne assignments, to U. S. Chemical Products Company, Inc.—1,751,295.

Process for Producing an Explosive. Martin Hahn, Boritz, near Riesa-on-the-Elbe, Germany.—1,751,326.

Apparatus for Manufacturing Zinc White. Joseph Marcel Henri Cornillat, Paris, France.—1,751,396.

Method for Making Zinc from Oxygen Compounds of Zinc or Substances Containing Oxygen Compounds of Zinc. Conway Freiherr von Girsewald and Hans Neumark, Frankfort-on-Main, Germany.—1,751,778.

Process of Working Natural Sodium Sulphate Deposits. George F. Andersen, Seattle, Wash., assignor, by direct and mesne assignments, to Weltha Process Corporation, Seattle, Wash.—1,751,901.

Salts of Alkaline-Earth Metals. Felix Lindner, Ludwigshafen-on-the-Rhine, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany.—1,751,932.

Manufacture of Active Silica. Fritz Stoewener, Ludwigshafen-on-the-Rhine, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany.—1,751,955.

Process of Recovering Nitric Acid from Weak Nitric Liquors. Heinrich Hirtz, Eilenburg, Germany.—1,752,086.

Apparatus for the Production of Hydrogen. Fernand Emile Lefebvre, Clichy, France, assignor to L'Oxhydrique Francaise, Malakoff, Seine, France.—1,752,187.

Process for Refining and Purifying Barium Sulphate. Henry V. Farr, Ferguson, Mo., assignor to Mallinckrodt Chemical Works, St. Louis, Mo.—1,752,244.

Chemical Engineering Processes and Equipment

Hydraulic Filter Press. William H. Mathers, Hollis, N. Y., assignor to Richard Dudgeon, Inc., New York, N. Y.—1,749,080.

Centrifugal Drier. Hans C. Behr, Scarsdale, N. Y.—1,749,369-70.

Drying Apparatus. William M. Strong, Santa Barbara, Calif., assignor to General Drying Engineering Corporation.—1,749,451.

Process of Dehydrating Materials. Justin F. Wait, New York, N. Y., assignor to National Aniline & Chemical Company, Inc.—1,749,455.

Evaporator. William Sieck, Jr., Winnetka, Ill., assignor to William Garrigue & Company, Chicago, Ill.—1,750,434.

Pulverizer Mill. Russell Orlando Groman, Catasauqua, Pa., assignor to Fuller-Lehigh Company, Fullerton, Pa.—1,750,636.

Process of Purifying Wax Distillates. Earl Petty, Winfield, Kan., assignor to De Laval Separator Company, New York, N. Y.—1,750,646.

Drying Apparatus. Ernest Hopkinson, New York, N. Y., assignor to General Rubber Company, New York, N. Y.—1,750,753.

Rotary Retort, Kiln, or Drum. Georg Cantieny, Berlin, Germany, assignor, by mesne assignments, to International Coal Carbonization Company.—1,751,127.

Apparatus for Compressing Air, Gases, or Vapors. Emilio Vianello, Milan, Italy.—1,751,537.

News of the Industry

A. C. S. Hears Midgley Tell of New Refrigerant

EVIDENCE of the unusual interest in the chemical industries in the South was to be seen in the unexpectedly large attendance at the Atlanta meeting of the American Chemical Society, April 7 to 11. About 1,450 members and guests registered for sessions at which more than 500 papers were presented. Of these the one that attracted most attention was Thomas Midgley's discussion of the use of organic fluorides as refrigerants.

Working with Dr. Albert L. Henne, a Belgian research chemist in the employ of the Frigidaire Corporation, Mr. Midgley has succeeded in developing dichloro-difluoro-methane as a non-flammable and comparatively non-toxic refrigerant. Tests have shown it to have highly desirable engineering characteristics. At present it is being made only on an experimental scale by treating carbon tetrachloride with antimony fluoride in the presence of antimony pertachloride. It is predicted that it will replace common refrigerants only under special conditions where ammonia, sulphur dioxide, etc., are hazardous to life and property.

Another technical feature was a symposium on insecticides conducted by R. C. Roark, of the U. S. Department of Agriculture. New fumigants, such as ethylene oxide and ethylene dichloride, as well as HCN and the chloroethanes, were discussed. Other papers dealt with contact insecticides, moth-proofing agents and stomach insecticides.

Under the chairmanship of Dr. Charles H. Herty, the cellulose and chemical education divisions held a joint symposium on the relation of cotton to such chemical industries as rayon, lacquer, explosives, and foods.

No action was taken at the council meeting on the several proposals looking toward a reorganization of the financial structure of the society. The committee on reorganization, headed by Dr. E. H. Volwiler, of Chicago, made a preliminary report with certain recommendations for strengthening the directorate and governing body. These are to be acted upon at the fall meeting.

Plans under consideration for this meeting, which will be held in Cincinnati Sept. 8-12, include a joint symposium by the industrial, petroleum and gas and fuel divisions on high-pressure gas reactions. This will be led by Dr. Norman W. Krase, of the University of Illinois. Another, participated in by the paint and varnish and dye divisions, will deal with colors for paints, lacquers, and inks. A third will discuss the fermentation industries.

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I.C.I. Defeats I.G. in Dye Patent Action

THE long-continued patent action in England relating to certain selection patents governing the manufacture of azo and monoazo dyestuffs between Imperial Chemical Industries and the I.G. Farbenindustrie ended last month in a judgment that all three German patents involved are invalid.

The I.G. sought to amend three of their patents of 1922 for the manufacture of azo dyestuffs by limiting them to the dyeing of cotton on the fiber. Imperial Chemical Industries, Ltd., as sole director and manager of the British Dyestuffs Corporation, and holder of 99 per cent of its issued capital, petitioned for the revocation of the patents on the grounds of prior publication and common general knowledge and insufficiency of description, and alleged that by reason of these patents the German Dye Trust would be able to extend its monopoly in the manufacture of azo dyestuffs and greatly hamper the petitioning company in its business.

The presiding justice summed up his conclusions on the three patents as follows:

"First, as a matter of law, there may well be a selection patent, but it must be a selection for a useful and special characteristic or property, indicated in clear terms by the patentees.

"Secondly, on the construction which I have placed on the promise in relation to fastness to kier boiling—fastness to a practical soda ash kier boil, the promise wholly fails.

"Thirdly, on the construction which the respondents seek to place upon the promises: a greater fastness to caustic soda kier boil in comparison with other similar dyestuffs to a varying degree, the characteristic as established is too vague, too uncertain and, nitro compounds being included, open to too many exceptions to enable the patents to be supported.

It was the first time that chemical selection patents had formed the basis of a court issue and the evidence was of such a technical nature that the judge had the assistance on the bench of Prof. Arthur Smithells, president of the Institute of Chemistry.

Muscle Shoals Settlement Faces Delay

ALTHOUGH the Senate has passed the Norris bill again, hopes for a Muscle Shoals settlement this term of Congress are not too bright. House opposition to government ownership seems insurmountable, and beyond that looms an almost certain veto, as happened when the bill went through both houses under President Coolidge. Still, attempts are being made to smooth out a compromise. The House Military Affairs Committee has the job in hand and is likely to turn out amendments which would require that the government operating board which the bill creates shall make further efforts to lease the properties.

This would be similar to Senator Black's proposal, which was rejected without a record vote. A properly drawn amendment, it is pointed out, might virtually do away with the government operation and let a private firm handle the works under the federal board. The main difference from the Cyanamid plan would be that the latter would work under the Secretary of War, probably under less stringent terms, and would gain eventual ownership instead of remaining a lessee.

Even if such an amendment could be reported promptly out of committee, which is doubtful, there is some thought that the House would pigeonhole it, declining to act on any revision of the Norris plan, thus blocking settlement for another year. The proposal of an entirely different plan by the House is thought unlikely, because the Senate could be expected to defeat it summarily.

Despite these obstacles to an end to the Shoals controversy, some observers believe that a compromise along the lines suggested might have a chance if permitted to come to a vote. Even the lobbyists lately so vigorous in supporting specific private offers seem to prefer this to no decision at all.

Events during the past month leading up to this state of affairs were matters of cut and dried procedure except for the sensational Senate Lobby Committee hearings, which may be dismissed as interesting but ineffective fireworks. The Senate debate on the Norris bill was mainly a rehash of statistics with moderately crowded galleries and a deserted floor. The Military Affairs Committee went through the motions of recalling more of the old witnesses to inform its members, but this was mainly marking time.

Pacific Coast Section of T.A.P.P.I. Meets

HOLDING ITS second biannual meeting, the Pacific Coast Section of the Technical Association of the Pulp and Paper Industry, spent Saturday, April 5, in Longview, Wash. Approximately 100 members and guests attended the technical session and a larger number the banquet held in the evening at the Monticello Hotel.

The morning opportunity of inspecting the world's largest sawmill, that of the Long-Bell Lumber Company, as well as the Kraft mill of the Longview Fibre Company, gave the visitors an interesting insight into the complete utilization of wood as carried out in Longview.

R. D. Wertheimer, resident manager of the Longview Fibre Company, as chairman of the section, and Dr. H. K. Benson, professor of chemical engineering, as secretary, had arranged a very interesting and profitable program of papers for the afternoon session.

Dr. Benson gave an interesting discussion of the New York meeting of the parent society and discussed the cooperative plans of the Pacific Coast Section.

J. B. Woods, chief forester of the Long-Bell Lumber Company, explained the plan and the work of his company in reforestation of cut-over areas. It has been found impossible to dispose profitably of lands after cutting timber for lumber purposes, and the Long-Bell Company has found that it is a sounder policy to keep the land for growing more timber. The company at present is reforestating at the rate of 2,500 acres per year by hand with an additional 1,500 acres per year by natural reseeding. The cost is low.

R. G. Tyler, of the University of Washington, discussed water-supply problems of pulp mills.

Paul D. V. Manning, Pacific Coast editor of *Chem. & Met.*, gave an industrial survey of the Pacific Coast process industries as affected by the pulp and paper industries, stressing the necessity and importance of the development of a "community of interests" on the part of the pulp industry with other process industries and pointing out the need for continued research in raw materials, wastes, and finished products.

The possibilities in the use of logging wastes as a raw material for this work were taken up by Allen H. Hodgson, of the U. S. Forest Service.

THE experimental work leading to a newly developed process for the manufacture of liquid sulphur dioxide was discussed by R. Leonard Hasche, of the American Smelting & Refining Company. The possibilities of resulting lower priced product in the manufacture of pulp was of interest.

Prof. W. L. Benschlein, of the University of Washington, gave the results of his research on the rate of cellulose extraction from fir wood. He has found that the rate of extraction is not affected by the resins present.

In a paper of great interest to engineers and plant executives, L. C. Peabody, of the Longview Fibre Company, brought out the relations which should exist between the cost accountant and the technical man. The importance of proper, not too much systematized cost accounting is no longer in fixing the selling price of the product but in furnishing the executive engineers with a barometer of proper operation.

The Longview Fibre Company practice furnished several illustrations for his points, notably the thirteen-period year on which the company now operates. This gives thirteen periods, each presenting the same number of working days, which greatly decreases inaccuracies in figuring production costs. The advantage of taking physical inventories at times when stocks are low rather than at definite dates also was mentioned.

Colloid chemistry as a means of definitely studying pulp and paper technology found an interesting thesis for Dr. Leo Friedman, of the University of Oregon.

The high lights of the evening banquet were addresses by M. E. Wertheimer, chairman of the board of the Longview Fibre Company, and W. G. Brown, superintendent of the Inland Empire Paper Company, Scott Henderson, as toastmaster, was unofficially assisted by A. H. Hooker, Jr., of the Hooker Electrochemical Company's Tacoma plant.

The next meeting is to be held in Portland, Ore., in October. From the degree of enthusiasm and interest shown, it is possible that a two-day session will be considered.

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Graduate Fellowships in Michigan Program

THE Michigan College of Mining and Technology is offering for the academic year of 1930-1931 twelve graduate fellowships carrying stipends of $1,200 each. Holders of these fellowships will be engaged in the study of various problems in connection with the general research program of the college for which the State of Michigan has provided the sum of $50,000 for the coming year. Research work in chemistry will include: investigation of the chemistry of native copper deposition; analytical methods for cyanide copper solutions; and determination of the surface tensions of solutions and liquids used in the flotation of copper ores.

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Production and Chemical Conference of A.G.A.

ENGINEERS and chemists from all parts of the United States and Canada are expected to attend the fourth Joint Production and Chemical Conference, to be held under the auspices of the Carbonization, Water-Gas and Chemical Committees, Technical Section, American Gas Association, at the Cleveland Hotel, Cleveland, Ohio, May 21-23.

Bakelite Wins Contention Against Importers

THE United States Court of Customs and Patent Appeals on April 10 rendered a decision upholding the ruling of the United States Tariff Commission refusing entry to this country of materials and products made of Bakelite. The defendants in the case were Frischer & Company, Randes Importing Company, Transatlantic Clock & Watch Company, Inc., Western Briar Pipe Company, and the National Council of Importers & Traders, Inc.

Complaint against importations of products made of Bakelite was made in 1925 on the ground of unfair competition. In 1927 the Tariff Commission in a public decision recommended that the President exclude from entry into the United States that grade of the material on which the Bakelite Corporation held patents.

In 1928 the case was again before the commission when the Bakelite Corporation charged foreign producers and American importers with infringement.

The court in affirming the decision of the Tariff Commission stated that it found that the appellants were engaged in importing material which constituted an infringement of the patent rights of the Bakelite Corporation, and that goods imported by the appellants were being sold to the purchasers as the goods of the Bakelite Corporation.

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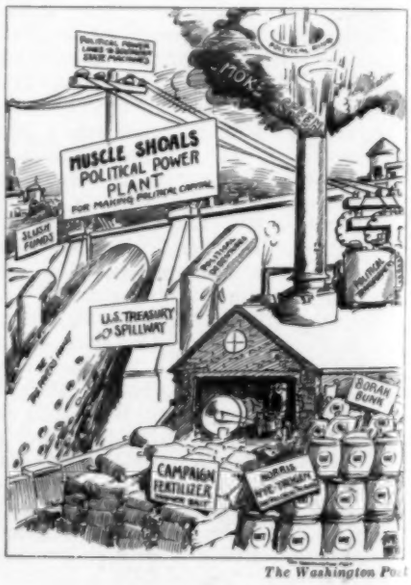
New Rayon Plant for Canada

Plans are now under way to establish a mill to manufacture rayon from wood fiber with a sawmill and wood byproducts plant in connection, at New Westminster, B. C. Engineers representing financial backers of the project have inspected the site, and are preparing reports. The plant, according to estimates, will cost from $500,000 to $1,000,000, but no details have been released.



The Washington Post

In Full Blast

NEWS FROM WASHINGTON

By Paul Wooton

Washington Correspondent of Chem. & Met.

TARIFF MAKING is behind closed doors again as the smooth-working conference committee between House and Senate rapidly ploughs through the commodity schedules. The bill finally passed the Senate after the coalition rebels had been dispersed. The House duly referred it to committee with the gentlemen's agreement that a separate vote would be taken on sugar, cement, lumber, and shingles. Casein, too, is held over for the present. Aside from this, the chemical rates all are decided, probably in their final form.

What the ten conferees are doing is to adjust the changes which the Senate made in the House bill so that their version will suit both chambers. At the rate they are going, the bill should be ready to report back to the House again by the first of May. Then come the final debates. The controverted items above mentioned soon will be cleared, but the debenture and the flexible clause may evoke considerable fireworks before it is all over. Anyhow, there seems no chance of the bill's failure.

Rather than discuss the changes made by the conference committee, a table has been prepared which shows such conference rates as differ from existing law. In addition have been added the changes adopted by the House and confirmed by the Senate which have not been mentioned in recent discussion but which nevertheless are of some importance. Thus the table can be applied to the Act of 1922 to show most of the actual changes which are being made in the chemical rates by the new law. Although the conference changes in chemical rates were numerous, few were large. The general trend seems slightly upward from the level set by the Senate.

A survey of the distribution and content of iodine in soil and waters throughout the United States is proposed in a bill (H.R. 11510) introduced in Congress on April 9 by Rep. Green, of Florida. The survey would be made by the Department of Agriculture under an annual appropriation of $7,000 for nine years.

Joint Conference Committee and Previous Tariff Changes Differing From Existing Rates

Duties are in cents per pound unless otherwise noted.
Paragraph numbers are those of the Senate bill.

Schedule 1—Chemicals, Oils, and Paints

Paragraph	Item	Rates Existing	Rates Proposed
1	Acetic acid not more than 65% by weight	¼	1¼
	Acetic anhydride	5	3½
	Boric acid	1½	1
	Formic acid	25%	3
	Tannic acid: less than 50% by weight	4	5
	50% or more and not medicinal	10	11
	50% or more and medicinal	20	18
	Arsenious acid or white arsenic	Free	2
	Gallic acid	8	6
	Oleic acid or red oil	1½	20%
	Tartaric acid	6	8
	Stearic	1½	25%
	Carbon dioxide one pound or less per carton	25%	.1
3	Acetone, ethyl methyl ketone, etc.	25%	20%
6	Aluminum sulphate containing not more than 15% of alumina and more iron than the equivalent of 0.1% of ferric oxide	3/10	¼
4	Methyl or wood alcohol or methanol	12	18
7	Ammonium sulphate	¼	Free
	Ammonium carbonate	1½	2
9	Calcium tartrate, crude	5%	Free
11	Amber and amberiod unmanufactured, n.s.p.f.	$1	50
	Synthetic gums and resins n.s.p.f.	25%	4 plus 30%
	Bleached shellac	25%	20%
12	Barium: carbonate, precipitated	1	1½
	chloride	1½	2
	dioxide	4	6
	oxide	25%	2½
15	Caffeine	$1.50	$1.25
	Caffeine citrate	25%	90
	Theobromine	10	75
	Tea waste	1	Free
16	Calcium acetate, crude	...	...
17	Calomel and corrosive sublimate	45%	22 plus 25%
18	Carbon tetrachloride	2½	1
	Chloroform	6	4
	Tetrachloroethane and trichloroethylene	35%	30%
19	Casein or lactarene	2½	Vote deferred; 5½ proposed
25	Chicle: crude	10	Free
	refined	15	5
26	Urea	35%	Free
	Diethylbarbituric acid	35%	$2.50
	Ethyl-hydrocupreine	25%	20c. oz.
28	Vanillin	45%	7 plus 45%
	Synthetic indigo "Color Index No. 1177"	45%	3 plus 20%
	Sulphur black "Color Index No. 978"		
30	Collodion and other liquid solutions of pyroxylin	35	30
31	Cellulose acetate: unmanufactured	40	50
	manufactured	60%	80%
	Cellulose compounds other than acetate: in transparent sheets not more than 0.032 and more than 0.003 in. thick	40	45
	sheets, bands and strips over 1 in. wide and not more than 0.003 thick	40	45%
32	Cellulose, vulcanized or hard fiber	35%	30%
33	Casein manufactured articles	25%	50%
36	Buchu leaves	10	Free
	Licorice root	½	Free
	Gentian	½	Free
	Sarsaparilla root	1	Free
	Belladonna, henbane, and stramonium	25%	Free
	Digitalis	25%	20%
37	Ergot	10	Free
38	Butyl and amyl acetate	25%	7
40	Formaldehyde solution or formalin	2	1½
	Hexamethylenetetramine	25%	11
41	Edible gelatin, value less than 40	3½ plus 20%	5 plus 20%
	Gelatin and glue, n.s.p.f.: value less than 40	1½ plus 20%	2 plus 25%
	value 40 or more	7 plus 20%	8 plus 25%
	Casein glue	25%	30%
43	Ink and ink powders, n.s.p.f.	20%	10%
44	Iodine, resublimed	20	10
47	Licorice extracts	25%	20%
48	Lemon or other citrus fruit juice unfit for beverage purposes	Free	5
49	Magnesium: carbonate, manufactures	1½	2
	sulphate or Epsom salts	½	¾
	oxide or calcined magnesia	3½	7
51	Camphor, refined or synthetic	6	5
52	Sperm oil, refined	10	14
	Spermaceti wax	20%	6
	Wool grease: containing more than 2% of free fatty acids	½	1
	2% or less free fatty acids not suitable for medical use	1	2
	same suitable for medical use	1	3
53	Linseed oil	3 1/10	4½
	Olive oil, weighing with immediate container less than 40 pounds	7½	9½
54	Palm kernel oil	Free	1
	Sesame oil	Free	3
	Soy-bean oil	2½	3½ but not less than 45%
56	Hydrogenated or hardened oils and fats	4	3
59	Opium containing not under 8½% of anhydrous morphine and advanced beyond the crude	$4	$3
..	Paris green and London purple	15%	Free
63	Phosphorous oxychloride and trichloride	25%	6
65	Paints, artists' and children's: In jars, tubes, etc., not over 1½ pounds and valued:		
	Under 20c. doz. pieces	40%	½c. each
	20c. or more	40%	40 plus 2c. ea.
67	Barium sulphate, precipitated or blanc fixe	1	1½
68	Ultramarine blues valued over 10	3	4
69	Decolorizing, deodorizing, or gas-absorbing chars or carbons	20%	45%
76	Vermilion reds containing quicksilver	28	35
78	Potassium: citrate	25%	14
	nitrate, refined	½	1
	permanganate	4	6
81	Sodium: bicarbonate or baking soda	½	Free
	citrate	25%	12
	nitrate	3	4½
	oxalate	25%	2½
	sulphate, anhydrous	$2 ton	$3 ton
	silicofluoride	25%	1½
	Phosphate (except pyro phosphate): by weight less than 45% water	½	1½
	n.s.p.f.—not specially provided for	½	½
83	Starch: potato	1½	2½
	all other, n.s.p.f.	1	1½
84	Dextrine: from potato starch or potato flour	2½	3
	n.s.p.f.	1½	2
86	Strychnine and salts thereof	15	20
90	Turpentine and rosin	Free	5%
91	Vanadic acid and vanadium compounds n.s.p.f.	25%	40%
93	Zinc sulphide	1½	3
94	Collodion emulsion	35%	25%
97	Tar, pitch, and oil from wood	Free	1

Schedule 2—Earths, Earthenware, and Glassware (excerpts from)

204	Magnesite: crude	1/10	11/40
	calcined	½	11/40
205	Cement	Free	Vote deferred 6c. per 100 lb. proposed.
206	Pumice stone, manufactured	0.55	½

Schedule 3—Metals and Manufactures of (excerpts)

339	Aluminum: utensils	11 plus 55%	8½ plus 40%
	scrap	5	3½
	sheet	9	7

What Lies Behind the Latest Chemical Consolidations?

***Bankers, industrialists, and technologists, as well, are greatly interested in the motive behind the various consolidations now taking place in American chemical industry. In this article Chem. & Met. attempts to answer some of these various inquiries by citing the underlying influences in one of the most interesting of recent mergers.*—The Editor.**

BEGINNING in 1904 with the first great industrial chemical consolidation—the formation of the German dye cartel—and extending through all of the history of chemical mergers there has been a common emphasis on interdependence and inter-relation of products and processes. It is of further significance that in all of the larger organizations, both in this country and abroad, nitrogen fixation and fertilizer manufacture hold a prominent place in the development of diversified chemical industries. This has been emphasized in *Chem. & Met.* on numerous occasions, most specifically perhaps in the January, 1928, charts of the corporate structure of such groups as the I. G. Farbenindustrie A.G. of Germany, Imperial Chemical Industries of England, Etablissements Kuhlman of France, and Allied Chemical and du Pont companies in this country.

It can readily be shown why fertilizer production must be combined with a general chemical industry for the most economical and efficient conduct of both. Nitrogen is equally useful as a chemical or a fertilizer. The nitric acid of the dye plant is the nitrate of the agriculturist, Sulphuric acid is largely a tool in its chemical applications, but in the fertilizer industry it is a raw material actually used up in manufacturing operations. It is only logical to farm it out as strong acid to the chemical plant and retrieve later in debits form for the agriculturist.

With this general perspective it is not difficult to understand the program behind the latest of the large chemical consolidations in this country: the American Cyanamid Company. One can clearly read its plans in the light of world chemical history.

The Cyanamid Company began in 1909 to produce cyanamid, primarily for direct fertilizer consumption. Like most organic compounds, its principal product was endowed with great flexibility. It is easily converted into ammonia, and the ammonia to the numerous salts or to nitric acid. Cyanamid is quite readily transformed into cyanide by the addition of another atom of carbon, thus opening up the metallurgical, fumigation, and synthetic chemical operations awaiting a cheap source of cyanide for a new class of reactions formerly excluded from commerce because of reagent cost. One of the earliest conversion products was urea, now the basis of a new plastic industry. Without going outside of its limit of raw materials, semi-manufactured products and derivatives of the principal product, the Cyanamid Company came directly into the agricultural, heavy chemical, and synthetic organic fields. Its directors early recognized the burden of conducting research and sales development work. Now, reversing the usual order of expanding from chemical to fertilizer, Cyanamid set about acquiring companies of like activities and consolidating their efforts.

Its fertilizer activities made it one of the largest users of sulphuric acid in the country. Other consumers and producers were naturally brought into the group—Calco and Kalbfleisch—not to mention a number of small organic specialty producers. Its position in ammonia production will ultimately take care of the nitric acid requirements of the companies, and their weak acids can go back into fertilizer production after suitable purification.

WHEN its own production of pharmaceuticals was small, the sales burden was disproportionately large. Acquisition of Lederle, and Davis and Geck amalgamated with Calco and Cyanamid pharmaceuticals offered an attractive list to the salesman calling on a highly specialized group of customers. Selden contributed not only to sulphuric acid but also to intermediates and pharmaceuticals.

Cyanamid, as the cheapest source of urea, naturally brought the urea plastics to the forefront, as represented in the Beetle product.

LONG a producer of solvents via cyanide, it was equally natural to combine with the synthetic resins and nitro-cellulose, the latter also entering into the acid consuming field; therefore, the Rezyl Corporation and the American Powder Company, with Selden again playing a part as supplier of reagents.

Selden's production, anthraquinone, and its children, the vat colors, fills out a dye development lacking in the original Calco set-up, which Beaver also strengthened materially. And so the list might be continued to account for the forty-odd branches shown on the accompanying Cyanamid tree.

The most interesting phase of this recent Cyanamid development is that it has taken a course just the reverse of the evolution of the consolidated industry in Germany, Italy, France, and England, in that the new combination has been worked out around the fertilizer industry, instead of adding a fertilizer industry to a chemical nucleus. In the European examples cited, the fertilizer division far overshadows the other branches. It is a question as to whether the house should be built first and foundation added, or the reverse.

(A) *Subsidiaries controlled but not wholly owned by American Cyanamid Co.*

MEN

in Chemical Engineering

JULIAN F. SMITH, former technical librarian for the B. F. Goodrich Rubber Company at Akron, Ohio, has joined the du Pont Ammonia Company to fill a similar position there. Dr. Smith has for several years conducted a technical reference service at Akron and Cuyahoga Falls, Ohio.

GILBERT N. LEWIS, professor of chemistry at the University of California, was one of the two recipients of the annual gold medal bestowed by the Society of Arts and Sciences for distinction in science. The presentation, which was made on April 17, cited Professor Lewis' efforts to dispel the vagueness in chemical work, especially by the use of thermodynamic principles.

C. D. PRICKETT, vice-president and director of the Hercules Powder Company, was honored at a dinner given by R. H. Dunham, president, and attended by members of the board of the company, for his 50th year of service in the explosives industry. Mr. Prickett came from a long line of powder makers, and became an executive in the Hercules company when it began its independent existence in 1912. For the past 18 years, he has directed the black powder activities.

H. A. WINKELMANN, long prominent in the technology of rubber, has joined the Palmer Gas Products Corporation at Shreveport, La., as chief chemist. He comes from a position as chief chemist of the Philadelphia Rubber Works and prior to that was with the B. F. Goodrich Company. His new duties will deal chiefly with the compounding of rubber.

LOUIS EHRENFELD, professor at Northwestern University, has been appointed to the post of curator of organic and industrial chemistry for the new Rosenwald Museum at Chicago.

MILTON C. WHITAKER, consulting chemical engineer and for many years active in various chemical industries, joined the American Cyanamid Company recently and has been elected president of the Catalytic Process Corporation, its newly formed subsidiary. Dr. Whitaker's long industrial experience began with a position in the Welsbach Company in 1903, after several years

Blank-Stoller, Inc.

of teaching. He stayed there until 1910, when he had become general superintendent, and in 1911 took up teaching again. After six years as professor of chemical engineering at Columbia University, he became a vice-president of the U. S. Industrial Alcohol Company and president of the U. S. Industrial Chemical Company, and filled these posts until 1927. In the following years Dr. Whitaker carried on a consultant's practice in New York City.

ALFRED H. WHITE, professor of chemical engineering at the University of Michigan and president of the American Institute of Chemical Engineers, was spokesman for his profession to the world-at-large in acknowledging the radio salute of the Westinghouse company on April 3.

JAMES WILLS CHAMBERLAIN has been appointed chief engineer and director of the U. S. Stoneware Company. He is a grandson of the company's founder and has been active in ceramic engineering since his graduation from Massachusetts Institute of Technology.

ANDREW M. FAIRLIE, consulting chemical engineer, of Atlanta, Ga., sailed for Great Britain and the Continent on April 11 aboard the "Homeric." He expects to return here early in June.

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OBITUARY

F. C. WALDECKER, director of research of the Winthrop Chemical Company and the H. A. Metz Laboratories, Inc., New York, died on March 31 in London in his 48th year, after falling ill on the ocean voyage from New York.

FIRMAN THOMPSON, chief of the division of chemistry of the California Department of Agriculture since 1926, died on Feb. 2, at the age of 56. Mr. Thompson, a graduate of the University of Michigan, passed through a varied technical and teaching experience before he became chief chemist for the firm of Samuel P. Sadtler & Son, Philadelphia, and later chief chemist of the Bowker Chemical Company at Everett, Mass.

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INDUSTRIAL NOTES

THE KOPPERS COMPANY and its affiliated concerns now have their New York offices at 60 East 42d Street.

BAILEY METER COMPANY, Cleveland, has promoted H. M. Hammond to manager of sales and engineering.

ARCO COMPANY, Cleveland, is erecting a plant at Los Angeles which will be headquarters for the new Arco Company, Ltd., of California. Howard Raeney will be general sales manager.

TUBE-TURNS, INC., has made the following appointments: E. F. Keating Company, 452 Water St., New York; Himelblau-Agazim & Co., 30 North Dearborn St., Chicago; Stewart Machinery Company, Buder Building, St. Louis.

AMERICAN ZINC INSTITUTE has moved its offices in New York to the Lincoln Building, 60 East 42d Street.

HILL CLUTCH MACHINE & FOUNDRY COMPANY has reopened its New York office under A. L. Whiteside.

PACIFIC CHEMICAL COMPANY, LTD., has been incorporated at Victoria, B. C., and will take over the business of C. D. Goepel and G. F. Donaldson.

AMERICAN AIR FILTER COMPANY, Louisville, Ky., is the new name of the combined Reed, Midwest, and National Air Filter companies.

DEEP ROCK OIL CORPORATION is the new name of the Shaffer Oil & Refining Company.

CHICAGO PNEUMATIC TOOL COMPANY, New York, has opened new branch offices at Perrine Building, Oklahoma City, Okla.; Philcade Building, Tulsa, Okla.; and Merchants and Manufacturers Building, Houston, Tex.

GLOBE STEEL TUBES COMPANY has moved its New York office to 60 E. 42d Street.

HARSHAW CHEMICAL COMPANY has bought a building at 1945 East 97th Street, Cleveland, to house its offices and laboratory.

CALENDAR OF FORTHCOMING EVENTS

AMERICAN CHEMICAL SOCIETY, 80th meeting, Cincinnati, Sept. 8 to 12.

AMERICAN ELECTROCHEMICAL SOCIETY, spring meeting, St. Louis, May 29-31.

AMERICAN GAS ASSOCIATION, National Gas Convention, New Orleans, May 5 to 8.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, spring meeting, Detroit, June 4-6.

AMERICAN INSTITUTE OF CHEMISTS, annual meeting, Philadelphia, May 10.

AMERICAN REFRACTORIES INSTITUTE, annual meeting, White Sulphur Springs, W. Va., May 19-20.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 23 to 27.

AMERICAN WELDING SOCIETY, annual meeting, New York, April 22-25.

EXPOSITION FOR CHEMICAL APPARATUS (Achema), Frankfort, Germany, June 10 to 22.

INTERNATIONAL EXPOSITION AT LIÉGE, Belgium, chemical and engineering sessions, Sept. 14 to 21.

NATIONAL METAL CONGRESS, 12th annual meeting, Chicago, Sept. 22-26.

SECOND PLENARY WORLD POWER CONFERENCE, Berlin, Germany, June 16 to 25.

ECONOMIC INFLUENCES
on production and consumption of CHEMICALS

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Irregular Trend in Chemical Trade During First Quarter

Distribution Follows Variations in Status of Consuming Industries

PRODUCTION of chemicals during the first quarter of this year appears to have been established on a scale relatively higher than that reached by general manufacturing industry. Considerable irregularity has been found, however, both in the production and distribution of chemicals. Distribution naturally has been affected by the position of consumers. In some cases consuming industries have operated more actively than was the case in the comparable period of last year, but the larger movement of chemicals thus occasioned was more than offset by a falling off in the volume of deliveries to other consumers. Hence the total consumption of chemicals in the first quarter of this year fell below that established in the first three months of 1929.

Owing to the lack of authoritative data it is not possible to compare production and consumption of chemicals in definite terms with the levels of a year ago. From figures available it is evident that oil refiners in the last three months drew more heavily upon raw materials than they did in the corresponding period of last year. While some curtailment in original production schedules has accompanied rayon manufacture, the fact that productive capacities were increased in the latter half of last year makes it probable this industry has increased its consumption of chemicals over the rate maintained in the corresponding period of a year ago. The fertilizer trade, likewise, has offered a ready outlet for chemicals, and the present year appears to be favored in a comparison with the January-March period of 1929.

IN CONTRAST to the three chemical-consuming industries above mentioned, reports from other industries almost unanimously indicate an operating scale below the 1929 level. The decline in building is reflected in sales of paint, varnish, and lacquer products. Sales in January-February reached a total of $48,599,302, which compares with $54,945,844 for January-February, 1929, or a falling off of 11½ per cent this year. Reports from sellers of dry colors, pigments, solvents, linseed oil, and naval stores are closely in line with the results shown by the sales totals for the finished products.

Automotive manufacturers draw upon a wide variety of chemical products and any changes in the rate of operations in this industry have a reflex action in the disappearance of chemicals. The domestic output of automobiles in January-February was 597,132, compared with 867,455 in the corresponding period of 1929. This drop of more than 31 per cent gives some indication of the decline in demand for chemicals in that direction.

The position in February of some of the more important chemical-consuming industries is given in the following table, together with available data on production.

	Feb., 1930	Feb., 1929
Production		
Acetate of lime, 1,000 lb.	9,588	11,400
Methanol, crude, gal.	615,032	685,567
Refined, gal.	394,647	449,800
Ethyl alcohol, 1,000 gal.	10,943	13,830
Rosin, wood, bbl.	39,615	33,152
Turpentine, wood, bbl.	7,478	6,436
Pine oil, gal.	238,943	204,700
Automobiles, cars, number	275,811	405,708
Taxis, number	1,022	2,108
Trucks, number	47,129	58,602
Byproduct coke, tons	4,004	4,090
Explosives, tons	33,244	35,392
Glass, containers, 1,000 gross	2,074	2,261
Glass, plate, 1,000 sq.ft.	9,804	11,289
Tires, pneumatic, 1,000	3,616	5,184
Petroleum refined, run to stills, 1,000 bbl.	72,414	72,031
Consumption		
Cotton, bales	495,204	577,235
Wool, 1,000 lb.	38,330	47,963
Silk, bales	49,852	57,683
Fertilizer, in South, tons	1,071,004	817,539
Cottonseed oil, bbl.	282,943	280,690
Linseed oil, shipments from Minneapolis, 1,000 lb.	5,493	13,214
Paint, varnish and lacquer, sales	$24,602,338	$28,979,212

As reports of improved conditions in March were common with respect to industry, the closing month of the quarter not only speeded up the rate of manufacturing operations but also created a more optimistic feeling with regard to the prospects for the second quarter. Building contracts increased materially and government economists announced that they had increased by a billion dollars their construction estimates for this year. They now estimate the total at $11,000,000,000. This represents public and private building and maintenance, including the activities of public utilities. The increase in the estimate is almost entirely in the field of commercial and industrial structures, and other private operations.

Reports from automobile centers, likewise, were of a more favorable tenor and where earlier estimates placed rubber consumption for March at about 37,000 tons, it is now held that consumption ran close to 39,000 tons.

MANUFACTURING production in February, after adjustments for seasonal changes, was larger than in January but showed a decline from a year ago, according to the weighted index of the Federal Reserve Board. The output of minerals in February showed declines from both the previous month and the same month of last year. Industrial production, including both manufacturing and minerals, was larger than in January but declined from February, 1929.

The general index of commodity stocks at the end of February was lower than at the end of the previous month but showed a gain over a year ago, the increase over last year being solely due to a gain in the holdings of raw materials. The index of stocks of manufactured goods in the hands of manufacturers, though showing a slight increase in February over the preceding month, was about 3 per cent lower than a year ago.

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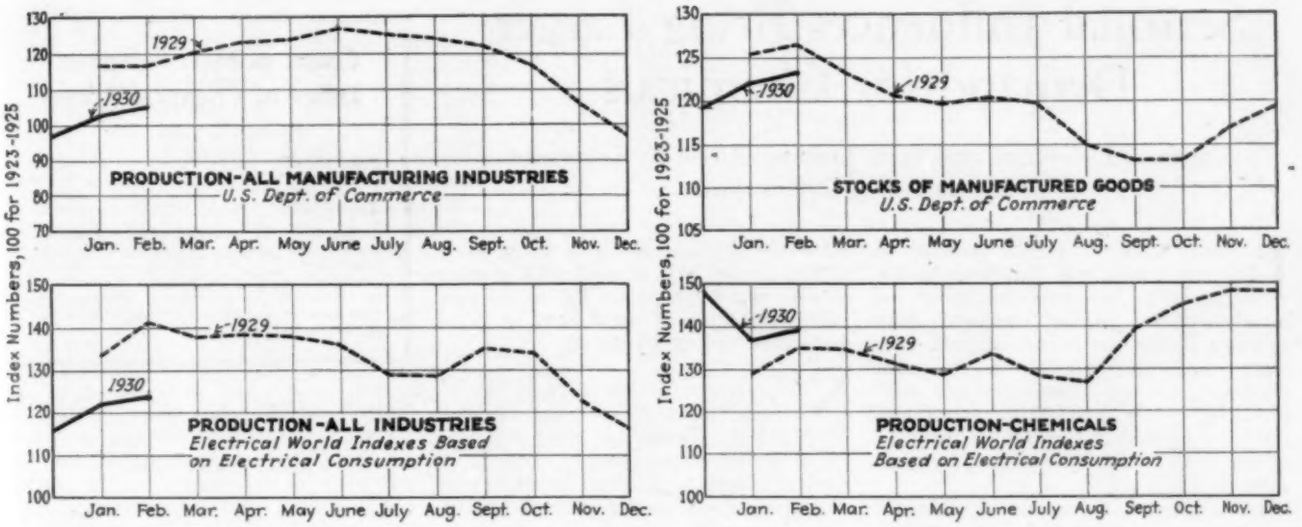
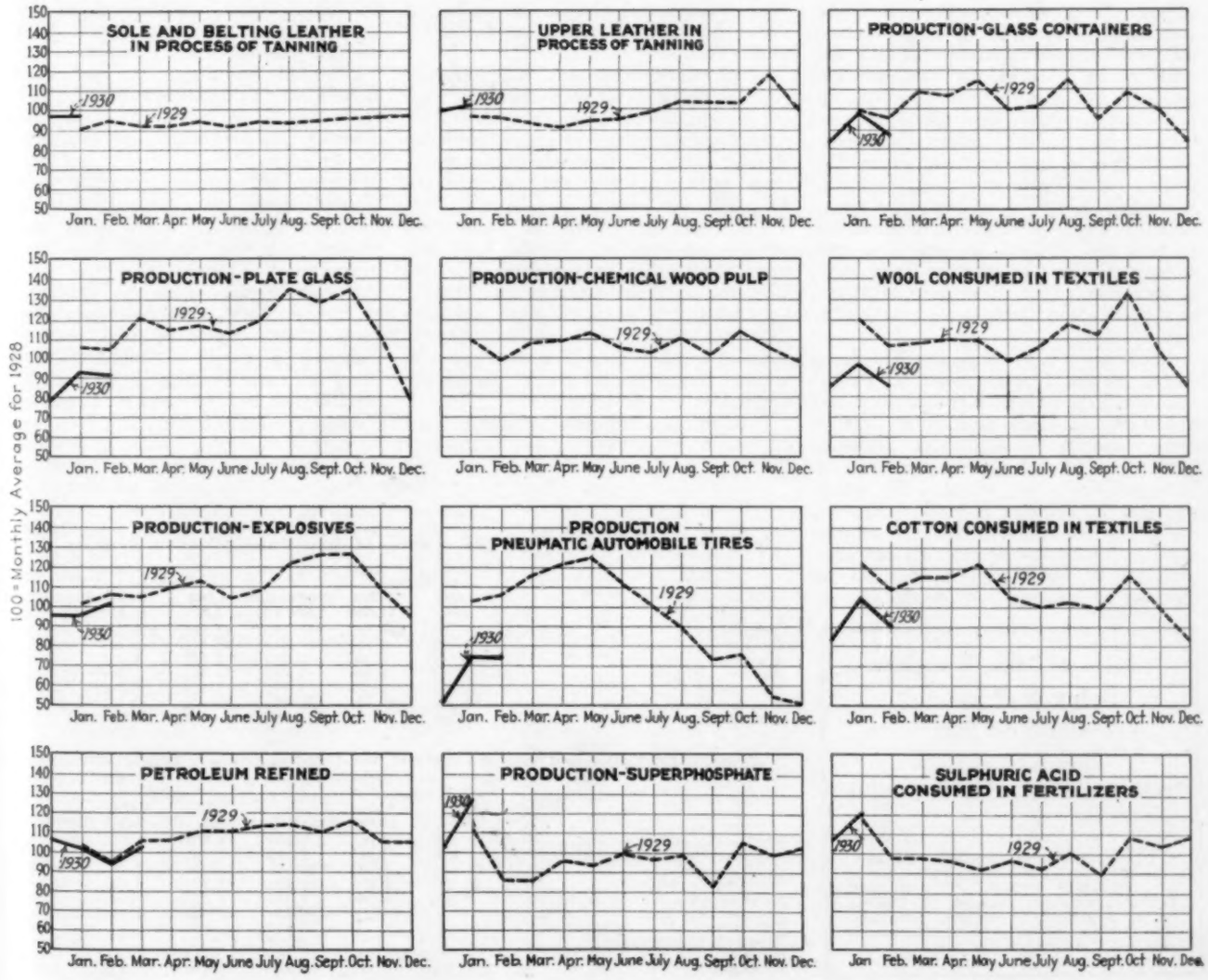
Natural Sodium Compounds and Boron Minerals Produced in the United States, 1920-1929

	Natural Sodium Compounds						Boron Minerals[4]	
	Carbonates[1]		Sulphates[2]		Borates[3]			
Year	Short Tons	Value	Short Tons	Value	Short Tons	Value	Short Tons	Value
1920	25,392	$961,574	14,851	$221,123	2,440	$330,482	120,320	$2,173,000
1921	17,000	601,250	5,000	8,750	3,000	284,000	50,000	1,600,000
1922	33,537	690,021	5,015	36,155	6,854	689,598	85,220	2,705,140
1923	35,440	751,850	10,080	100,000	13,920	924,090	136,650	3,994,790
1924	44,890	835,170	16,200	174,600	15,330	816,080	116,110	3,183,910
1925	45,910	922,760	9,940	84,380	17,450	1,087,970	113,700	3,085,660
1926	56,750	1,154,840	19,620	166,800	17,110	1,005,110	115,970	3,128,110
1927	67,240	1,253,352	23,080	168,882	55,450	2,412,090	109,080	3,473,399
1928	79,830	1,578,256	6,580	42,485	119,970	3,651,487	131,000	3,999,773
1929	102,930	1,916,632	7,540	41,199	164,720	4,149,835	169,870	4,515,375

[1]Soda ash, bicarbonate and trona; 1923-1926 also includes sal soda.
[2]Salt cake and glauber's salt.
[3]1920-1926, borax; 1927-1929, borax and kernite.
[4]1920-1926, borax and colemanite; 1927-1929, borax, kernite, and colemanite; 1925 and 1927-1929 also include boric acid.

ACTIVITY IN PRODUCING AND CONSUMING INDUSTRIES


PRODUCTION-ALL MANUFACTURING INDUSTRIES
U.S. Dept. of Commerce
STOCKS OF MANUFACTURED GOODS
U.S. Dept. of Commerce
PRODUCTION-ALL INDUSTRIES
Electrical World Indexes Based on Electrical Consumption
PRODUCTION-CHEMICALS
Electrical World Indexes Based on Electrical Consumption
Index Numbers, 100 for 1923-1925
1929
1930
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.



MARKET CONDITIONS *and* PRICE TRENDS

Seasonal Influences Bring Larger Demand for Chemicals

Contract Deliveries and Spot Trading Aided by Increased Manufacturing Operations

IMPROVEMENT in the position of different consuming industries in the last month has had the effect of broadening the call for chemicals both as regards the movement against contracts and the demand in the spot market. Seasonal conditions are contributing to the quickening trend and this is especially noticeable in the case of materials which enter into paint and varnish manufacture.

Developments of market significance in the last month include the approval by the Federal Trade Commission of a code of trade practices for the solvents industry. In its approved form, the code condemned the following practices as "unbusinesslike, unethical and discriminatory": Variations from open and publicly announced terms; secret rebates and special allowances to customers on storage, advertising, etc.; acceptance of orders at old prices following price changes; making combination sales involving solvents; failure to retain price differentials or charges for barrels and drums; payments of customers' brokerage, and ordinary misbranding in order to dispose of stocks at a price other than that announced at time of sale.

Importance also was attached to a ruling of the Commissioner of Prohibition which makes it mandatory for producers of ethyl acetate to furnish daily reports of shipments, showing quantities involved, name and address of consignee, and the manner in which shipment or delivery is made. According to rumors in the market, the depression in prices for acetate of soda has been caused by a large production on the part of interests outside the chemical industry who have been using ethyl acetate to produce alcohol with acetate of soda as a byproduct. Hence the new ruling on sales of ethyl acetate is of more than ordinary interest.

NEWS from foreign markets has included a report that the German Nitrogen Syndicate has been renewed for a period of five years. The I. G. Farben interests, leading producers of nitrogen, were alloted a quota of 750,000 tons of primary nitrogen annually, while the quota of the Ruhr nitrogen synthetic plants amounts to 110,000 tons the first year, 145,000 tons the second year, and the third year the maximum of 160,000 tons.

It also is reported that the temporary sales agreement between the two leading Belgian associations of producers of ammonium sulphate, effective until the end of April, 1930, establishes a practical monopoly for this product in Belgium.

The Belgian output of this commodity amounts to 200,000 tons annually. Further agreements of the Belgians with the German and British manufacturers of ammonium sulphate fixes the price of this product on the Belgian market at 152 francs per 100 kilos. Negotiations for a permanent agreement are in progress.

Competition between synthetic and natural camphor has been regarded as important enough to warrant a survey by the Chemical Division of the Department of Commerce. The survey places output of the synthetic product at about 15,000,000 lb. annually, of which 12,000,000 lb. is made in Germany, principally from American turpentine. Total consumption of both natural and synthetic camphor is distributed approximately as follows:

Celluloid industry, 66 per cent; manufacture of disinfectants and similar products, 14 per cent; pharmaceutical industry, 10 per cent; and explosives, 10 per cent.

Imports of synthetic camphor by the United States have been steadily upward during the past seven years, while imports of the natural have been irregular.

In confirmation of the overproduction of carbon black, a report from Texas gives 1929 output of that state as reaching a total of 140,901,000 lb. Total domestic production in 1928 was 248,790,000 lb., of which Texas accounted for 100,800,000 lb.

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1927

This month	**97.36**
Last month	97.90
April, 1929	100.31
April, 1928	100.04

Alcohol, methanol, and formaldehyde were largely responsible for the lowering in the weighted index number. Other selections were easy in tone with no open change in quotations. Ethyl acetate sold at higher average levels.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1927

This month	**94.46**
Last month	91.79
April, 1929	97.65
April, 1928	98.22

Higher markets prevailed for cottonseed and linseed oils. China wood oil also was firmer. Tallow sold below last month's levels. Menhaden is in a nominal position, awaiting the coming fishing season. Glycerine was quiet and unchanged.

Domestic Production and Sales of Dyes and Other Finished Coal-Tar Products

	1929			1928		
	Sales			Sales		
	1,000 Lb.	Value $1,000	Production 1,000 Lb.	1,000 Lb.	Value $1,000	Production 1,000 Lb.
Dyes	104.690	$44.593	110.195	93.303	$39.793	96.625
Color lakes	11.494	6.701	11.834	12.045	6.589	12.127
Medicinals	4.745	8.356	5.000	4.005	8.651	4.008
Flavors	2.252	3.506	2.290	1.966	1.296	1.746
Perfumes	1.477	1.072	1.596	1.619	1.000	1.578
Synthetic phenolic resins	30.263	10.586	31.471	20.779	7.212	20.411
Photographic chemicals	.580	.791	.581	.494	.696	.479

Domestic Production and Sales of Important Non-Coal-Tar Synthetic Organic Chemicals

	1929			1928		
	Sales			Sales		
	1,000 Lb.	Value $1,000	Production	1,000 Lb.	Value $1,000	Production
Amyl acetate and sec amyl acetate	4.963	$1.102	5.658	4.458	1.092	4.290
Amyl alcohol and sec amyl alcohol	4.081	.945	7.547	2.705	.646	4.801
Butyl acetate	23.932	4.103	30.998	20.776	3.785	30.030
Ethyl acetate, 85%	48.901	5.691	66.694	43.911	4.745	58.578
Ethyl ether U.S.P.	5.307	1.680	6.147	4.623	1.482	5.933
Formaldehyde 40%	.....	.....	51.786	27.934	2.492	38.718
Gallic acid	.....	.....	.458	.....	.....	.433
Hexamethylenetetramine	.....	.....	2.368	.....	.....	1.662
Pyrogallic acid	.....	.....	.135	.....	.....	.142
Xanthates	6.278	.871	6.439	5.516	.628	5.458

MARKET APPRAISAL OF CHEMICAL INDUSTRY

American Potash & Chemical Corporation will expend $4,500,000 to increase production of potash and borax at Trona, Calif.

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Freeport Texas Company reports for quarter ended Feb. 28, 1930, net income of $1,007,784 after taxes, equivalent to $1.38 a share on 729,844 shares of no-par stock. This compares with $737,037, or $1.01 a share, in first quarter of 1929.

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Wesson Oil & Snowdrift Company reports for the six months ended Feb. 28 a consolidated net profit of $1,447,059 after depreciation and taxes, equal after preferred dividends to $1.08 a share on 600,000 common shares. This compares with $1,173,247, or $2.25 a share, in the corresponding period a year ago.

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An agreement has been reached to merge the Libbey-Owens Glass Company and the Edward Ford Plate Glass Company, both of Toledo, Ohio, according to statements made by officers of the two companies. The new company is to be called the Libbey-Owens-Ford Glass Company and will have a combined capacity of about 50,000,000 square feet of plate glass a year.

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The Sherwin-Williams Paint Company has had admitted to unlisted trading privileges on the New York Curb Exchange 400,000 shares of 6 per cent preferred stock, series AA.

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National Lead Company has purchased Morris P. Kirk & Son, Inc., manufacturer of litharge and mixed metals, Los Angeles, Calif.

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Canadian Industrial Alcohol Company, Ltd., directors have deferred the regular dividend of 38c. a share on its A and B common stocks for the quarter ended March 31.

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Net profit of U. S. Industrial Alcohol Company for 1929 was $4,720,858, equivalent to $12.63 a share on 373,846 shares of outstanding no-par stock. This compares with $3,777,801, or $10.29 a share on 320,000 shares of stock for 1928.

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Report of Allied Chemical & Dye Corporation and subsidiaries for year ended Dec. 31, 1929, shows net income of $30,198,523, equivalent to $12.60 a share on 2,178,109 no-par shares of common stock. This compares with $26,962,441, or $11.11 a share, in 1928. Surplus after dividends was $14,379,926 against $11,143,844 in previous year.

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Union Carbide & Carbon Corporation reports for 1929 net profit of $35,427,024, equal to $4.19 a share on 8,453,723 average shares outstanding at the end of last year, against $30,577,382 earned in 1928, equal to $3.40 a share on the 8,981,581 shares now outstanding.

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Net profit of Imperial Chemical Industries, Ltd., for year ended Dec. 31, 1929, was £5,780,208 after provision for obsolescence and income taxes, compared with £5,212,703 in 1928.

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A temporary receiver has been appointed for the Chemical & Dye Corporation, formerly known as the Chemical Corporation of America. The receivership was requested because of internal dissension. Assets are listed at $300,000.

Price Range 1930 High	Price Range 1930 Low	Stock	Price Range in March: March 1	March High	March Low	March 31
24	19	Agfa Ansco Corp	20	24	20	23½
148	118	Air Reduction	145¼	148	131	143¼
2½	1⅛	Ajax Rubber	2	2½	1⅛	2
304½	255½	Allied Chemical	274½	304½	265½	303½
345	275	Aluminum Co.	...	336½	310½	336½
10⅛	6⅛	Am. Ag. Chemical	7½	10⅛	7½	10
33	19½	Am. Commercial Alcohol	28½	29¼	19½	23¾
37	25½	American Cyanamid, B	26	37	25½	33¼
5¼	4½	American Hide & Leather	4½	5¼	4¼	....
51½	44	American Metals	47½	49	44	48½
78½	69¾	Am. Smelting & Refining	75½	77½	70½	76
22½	10	Am. Solvents & Chemical	15¼	22½	15	18¾
28¾	15¾	Anglo-Chile Nitrate	....	28¾	17½	28¾
27⅞	22½	Archer-Daniels-Midland	24¾	26½	22½	24½
8½	5½	Armour, Ill. A	5¾	8½	5½	7¾
49½	36¼	Atlantic Refining	38¾	49½	38¾	48¾
106	81½	Atlas Powder	87¼	106	87½	103¾
70½	60½	Beechnut Packing	65¾	65¾	62¾	....
73	70	Bon Ami, A	71	73	70	....
28	28	California Petroleum	28	28	28	....
35	23	Celanese	24	24½	23	23¾
20	13½	Celluloid Corp	13½	15	13½	....
15⅞	11	Certainteed	13½	14¾	12½	12½
28½	24¾	Chickasha Cotton Oil	27	27	24¾	25¾
63¾	60	Colgate-Palmolive-Peet	62¾	63½	60	63
199	168½	Columbian Carbon	189	199	175	176¾
37½	27½	Commercial Solvents	31½	37½	31½	37
102¾	87½	Corn Products	94½	102¾	92¼	100½
43¾	28⅛	Davison Chemical	38½	43¾	37	43
42¾	30¾	Devoe & Raynolds	41½	42¾	39	....
75	71	Dow Chemical	71	72	71	....
143½	112½	Du Pont	126½	143½	125	140
120	114½	Du Pont, 6 pc. db	116¾	120	116¾	120
244¼	175¾	Eastman Kodak	219½	244¼	215½	236½
33½	26	Firestone Tire	27⅛	29¾	27	29¾
4½	3	Fisk Rubber	3½	4	3½	3¾
49¾	38⅛	Freeport Texas	42¾	49¾	41⅛	47
70⅜	49½	General Asphalt	54⅜	70⅜	54⅜	67¼
14¼	....	Gen. Industrial Alcohol	13	13	8	....
38	31	Glidden Co	35	38	33½	35¼
46¾	37¾	Gold Dust	43	45½	40⅜	42¾
58½	40½	Goodrich Co	47⅜	58½	46½	57
85	78½	Hercules Powder	81	83	80	83
23	20	Heyden Chemical	....	22	20	21
110	52½	Houston Oil	67¼	110	67½	102½
7	5¼	Imperial Chemical Ind	5⅞	6⅛	5⅛	....
124	90	Industrial Rayon	108½	110	95	....
7¾	4½	Int. Ag. Chemical	6½	7¾	5½	7¾
43½	31⅛	International Nickel	40½	43½	38	43
17	12½	International Paper, C	14½	17	13¾	14⅞
85¼	69	International Salt	73½	85½	73	81½
23⅞	20⅞	Kellogg, Spencer & Sons	21	22	21	22
5¼	3¼	Kelly-Springfield	4½	5¼	4½	5
11	6½	Lee Rubber & Tire	7½	11	7½	10½
34	29⅞	Lehn & Fink	31	33½	31	31½
31½	19½	Libby-Owens	23½	31½	23	29½
81¼	52¼	Liquid Carbonic	65½	81¼	65	79
35½	25¼	McKesson & Robbins	31½	31¾	25½	29
51¾	37½	Mathieson Alkali	43¾	51¾	43¾	50
60	48⅜	Monsanto Chemical	56	56	48⅜	53¾
39½	29	Nat'l Distillers Products	36¾	38¾	34½	34⅞
189½	137	National Lead	181	184½	170½	170½
91½	66½	New Jersey Zinc	85	91½	84	89¾
85	51	Newport Co., A	63	85	61	78
74¾	66½	Ohio Oil	68½	74¾	68½	74¾
60¾	52½	Owens-Ill. Glass	60½	60½	58½	59½
39	29¼	Phillips Petroleum	33¾	39	34¾	38⅜
58½	53	Pittsburgh Plate Glass	....	58½	53	57¾
57½	53½	Pratt & Lambert	....	56	53½	55
70½	52⅜	Procter & Gamble	67½	69¾	64¼	67¾
25½	21⅛	Pure Oil	22½	25½	22½	25⅜
80	80	Sherwin-Williams	....	80	80	....
34½	18	Silica Gel	....	34½	26¾	34½
29¾	21⅜	Sinclair Oil	24½	29¾	24½	29¾
36¾	28⅞	Skelly Oil	29½	36¾	29	36¼
67	55½	Standard Oil, Cal	58¾	67	58¾	66
75	58	Standard Oil, N. J	58¾	75	58¾	74½
35¾	31¼	Standard Oil, N. Y	32½	35¾	32	35¾
3	1½	Standard Plate Glass	2	3	2	....
65¾	53	Sun Oil	54	65¾	53¾	....
....	....	Swan & Finch	....	....	....	....
34½	30¼	Swift & Co	32½	32½	30¾	31½
16½	13	Tennessee Copper & Chemical	14¾	16½	14	16½
58¾	50¾	Texas Corporation	51¾	58¾	51¾	58½
67¾	54¼	Texas Gulf Sulphur	63½	67¾	59½	64½
16	10¾	Tidewater Assoc. Oil	11¾	16	11½	15¾
178¾	110	Tubize Silk	132	139½	110	121
106¾	76	Union Carbide	92½	106¾	91½	105
47⅞	41½	Union Oil, Cal	42¾	47⅞	42	46
74½	44¾	United Carbon	50¼	74¾	49¾	69½
42	19½	United Chemicals	....	34	30	30
32½	25	United Piece Dye	....	32½	26½	28⅜
139¾	98½	U. S. Industrial Alcohol	118½	122¾	98½	103
11½	7⅛	U. S. Leather	8	11½	8¼	10½
33½	21½	U. S. Rubber	26¾	33½	26¼	33½
96¾	88½	Vacuum Oil	....	....	....	92¾
124½	49⅞	Vanadium Corp	70½	124½	69½	111½
46	37½	Vick Chemical	40½	46	40½	45½
8½	5½	Va.-Car. Chemical	6	8½	5½	8½
29	22½	Wesson Oil	26½	29	25½	29
59½	37	Westvaco Chlorine	58½	58½	52	54
7¼	3½	Wilson & Co	3½	7¼	3½	....

CURRENT PRICES *in the* NEW YORK MARKET

THE following prices refer to round lots in the New York Market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to April 12.

Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.11 -$0.12	$0.11 -$0.12	$0.14 -$0.15
Acid, acetic, 28%, bbl., cwt.	3.88 - 4.03	3.88 - 4.03	3.88 - 4.03
Boric, bbl, lb.	.06½- .07	.06½- .07	.06½- .07
Citric, kegs, lb.	.46 - .47	.46 - .47	.46 - .47
Formic, bbl, lb.	.10½- .11	.10½- .11	.10½- .11
Gallic, tech., bbl., lb.	.50 - .55	.50 - .55	.50 - .55
Hydrofluoric 30% carb, lb.	.06 - .07	.06 - .07	.06 - .07
Latic, 44%, tech., light, bbl., lb.	.11½- .12	.11½- .12	.11½- .12
22%, tech., light, bbl., lb.	.05½- .06	.05½- .06	.05½- .06
Muriatic, 18°, tanks, cwt.	1.00 - 1.10½	1.00 - 1.10	1.00 - 1.10
Nitric, 36°, carboys, lb.	.05 - .05½	.05 - .05½	.05 - .05½
Oleum, tanks, wks., ton	18.50 -20.00	18.50 -	18.00- 20.00
Oxalic, crystals, bbl., lb.	.11 - .11½	.11 - .11½	.11 - .11½
Phosphoric, tech., c'bys., lb.	.08½- .09	.08½- .09	.08½- .09
Sulphuric, 60°, tanks, ton	11.00 -11.50	11.00 -11.50	11.00 -11.50
Tannic, tech., bbl., lb.	.35 - .40	.35 - .40	.35 - .40
Tartaric, powd., bbl., lb.	.37½- .39	.38½- .39	.38 - .39
Tungstic, bbl., lb.	1.40 - 1.50	1.40 - 1.50	1.00 - 1.20
Alcohol, ethyl, 190 p'f., bbl., gal.	2.63 -	263- 2.71	2.68½- 2.71
Alcohol, Butyl, tanks, lb.	16½- .17	.16½- .17	.17½- .18
Alchol, Amyl, dr. gal.	1.90 - 2.10		
From Pentane, tanks, lb.	.236-	.236-	
Denatured, 190 proof			
No. 1 special dr., gal.	.43 -	.49 -	.48 -
No. 5, 188 proof, dr., gal.	.44 -	.50 -	.48 -
Alum, ammonia, lump, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Chrome, bbl., lb.	.05½- .05½	.05½- .05½	.05½- .06
Potash, lump, bbl., lb.	.03½- .04	.03 - .03½	.02½- .03½
Aluminum sulphate, com., bags, cwt.	1.40 - 1.45	1.40 - 1.45	1.40 - 1.45
Iron free, bg., cwt.	1.90 - 2.00	2.00 - 2.10	2.00 - 2.10
Aqua ammonia, 26°, drums, lb.	.03 - .04	.03 - .04	.03 - .04
Ammonia, anhydrous, cyl., lb.	.15 -	.15 -	.14 -
Ammonium carbonate, powd. tech., casks, lb.	.12½- .13	.12½- .13	.12 - .13
Sulphate, wks., cwt.	2.10 -	2.10 -	2.35 -
Amylacetate tech., tanks, lb., gal.	2.22 -	2.22 -	
Antimony Oxide, bbl., lb.	.09 - .10	.09 - .10	.09 - .10
Arsenic, white, powd., bbl., lb.	.04 - .04½	.04 - .04½	.04 - .04½
Red, powd., kegs., lb.	.09 - .10	.09 - .10	.09 - .10
Barium carbonate, bbl., ton	58.00 -60.00	58.00 -60.00	57.50 -60.00
Chloride, bbl., ton	63.00 -65.00	65.00 -67.00	64.00 -70.00
Nitrate, cask, lb.	.07½- .07¾	.07½- .08	.08 - .08¼
Blanc fixe, dry, bbl., lb.	.03½- .04	.03½- .04	.04 - .04½
Bleaching powder, f.o.b., wks., drums, cwt.	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Borax, bbl., lb.	.033- .033	.033- .033	.02½- .03
Bromine, cs., lb.	.45 - .47	.45 - .47	.45 - .47
Calcium acetate, bags., cwt.	4.50 -	4.50 -	4.50 -
Arsenate, dr., lb.	.07 - .08	.07 - .10	.06½- .07
Carbide drums, lb.	.05 - .06	.05 - .06	.05 - .06
Chloride, fused, dr., wks., ton.	20.00 -	20.00 -	20.00 -
flake, dr., wks., ton.	22.75 -	22.75 -	22.75 -
Phosphate, bbl., lb.	.08 - .08½	.08 - .08½	.07 - .07½
Carbon bisulphide, drums, lb.	.05½- .06	.05 - .06	.05 - .06
Tetrachloride drums, lb.	.06½- .07	.06½- .07	.06½- .07
Chlorine, liquid, tanks, wks., lb.	.02½-	.02½-	.03 -
Cylinders	.04½- .06	.04½- .06	.05 - .08
Cobalt oxide, cans, lb.	2.10 - 2.20	2.10 - 2.20	2.10 - 2.25
Coppersa, bgs., f.o.b. wks., ton.	15.00 -18.00	15.00 -16.00	16.00 -17.00
Copper carbonate, bbl., lb.	.13 - .20	.13 - .20	.19 - .21
Cyanide, tech., bbl., lb.	.45 - .46	.49 - .50	.49 - .50
Sulphate, bbl., cwt.	5.50 - 6.00	5.50 - 6.00	6.50 - 6.60
Cream of tartar, bbl., lb.	.26½- .27	.26½- .27	.27½- .28
Diethylene glycol, dr., lb.	.11 - .13	.11 - .13	.10 - .15
Epsom salt, dom., tech., bbl., cwt.	1.75 - 2.15	1.75 - 2.00	1.75 - 2.00
Imp., tech., bags, cwt.	1.15 - 1.25	1.15 - 1.25	1.15 - 1.25
Ethyl acetate, drums, lb.	12½-	12½-	12.5 -
Formaldehyde, 40%, bbl., lb.	.07½- .08	.07¼- .08	.09½- .10
Furfural, dr., lb.	.15 - .17½	.15 - .17½	.15 - .17
Fusel oil, crude, drums, gal.	1.30 - 1.40	1.30 - 1.40	1.30 - 1.40
Refined, dr., gal.	1.90 - 2.00	1.90 - 2.00	2.50 - 3.00
Galubers salt, bags, cwt.	1.10 - 1.20	1.10 - 1.20	1.00 - 1.10
Glycerine, c.p., drums, extra., lb.	.14 - 14½	.14 - .14½	14 - .15
Lead:			
White, basic carbonate, dry casks, lb.	.08½-	08½-	08½-
White, basic sulphate, sck., lb.	.07½-	.07½-	.08 -
Red, dry, sck., lb.	.09½-	09½-	.10½-
Lead acetate, white crys., bbl., lb.	13 - .14	13 - .14	.13 - .13½
Lead arsenate, powd., bbl., lb.	13 - .14	.14 - .15	.12 - .13
Lime, chem., bulk, ton.	8.50 -	8.50 -	8.50 -
Litharge, pwd., csk, lb.	08½-	08½-	08½-
Lithopone, bags, lb.	05½- .06	05½- .06	.05½- .06½
Magnesium carb., tech., bags, lb.	06 - .06½	06 - .06½	06½- .07
Methanol, 95%, tanks, gal.	.38 -	.43 -	.55 -
97%, tanks, gal.	.45 -	.45 -	.55 -
Synthetic, tanks, gal.	.40½- .45		
Nickel salt, double, bbl., lb.	.13 - 13½	13 - .13½	13 - .13½
Single, bbl., lb.	.13 - .13½	13 - .13½	.13 - .13½
Orange mineral, csk., lb.	.11½-	.11½-	.12½-
Phosphorus, red, cases, lb.	.42 - .44	.42 - .44	.55 - .57
Yellow, cases, lb.	.31 - .32	.31 - .32	.32 - .33
Potassium bichromate, casks, lb.	.09 - .09½	.09 - .09½	.09 - .09½
Carbonate, 80-85%, calc., csk., lb	.05½- .06	.05½- .06	.05½- .06
Chlorate, powd., lb.	.08½- .09	.08½- .09	.06½- .07
Cyanide, cs., lb.	.52 - .55	.52 - .55	51 - .53
First sorts, csk., lb.	.08½- .09	.08½- .09	.08½- .09
Hydroxide (c'stic potash) dr., lb	.06½- .06½	.06½- .06½	.07½- .07½
Muriate, 80% bgs., ton	36.75 -	36.75 -	36.40 -
Nitrate, bbl., lb.	.06 - .06½	.06 - .06½	.06 - .07½
Permanganate, drums, lb.	.16 - .16½	.16 - .16½	.15 - .16
Prussiate, yellow, casks, lb.	.18½- .19½	.18½- .19	.19 - .19½
Sal ammoniac, white, casks, lb	.046- .05	.046- .05	.047- .05
Salsoda, bbl., cwt.	.90 - .95	.90 - .95	.90 - .95
Salt cake, bulk, ton	22.00 -24.00	22.00 -24.00	16.00 -18.00
Soda ash, light, 58%, bags, contract, cwt.	1.32 -	1.32 -	1.32 -
Dense, bags, cwt.	1.35 -	1.35 -	1.35 -
Soda, caustic, 76%, solid, drums, contract, cwt.	2.90 - 3.00	2.90 - 3.00	2.90 - 3.00
Acetate, works, bbl., lb.	.03 - .04	.03 - .04	.05 - .05½
Bicarbonate, bbl., cwt.	2.00 - 2.25	2.00 - 2.25	2.00 - 2.25
Bichromate, casks, lb.	.07 - .07½	.07 - .07½	.07 - .07½
Bisulphate, bulk, ton.	16.00 -18.00	16.00 -18.00	12.00 -15.00
Bisulphite, bbl., lb.	.03½- .04	.03½- .04	.03½- .04
Chlorate, kegs, lb.	.07½- .08	.07½- .08	.06½- .06½
Chloride, tech., ton	12.00 -14.75	12.00- 14.75	12.00 -14.00
Cyanide, cases, dom., lb.	.18 - .22	.18 - .22	.18 - .22
Fluoride, bbl., lb.	.08½- .09½	.08½- .09½	.08½- .09
Hyposulphite, bbl., lb.	2.40 - 2.50	2.40 - 2.50	2.50 - 3.00
Nitrate, bags, cwt.	2.16 -	2.16 -	2.15 -
Nitrite, casks, lb.	.07½- .08	.07½- .08	.07½- .08
Phosphate, dibasic, bbl., lb.	.03 - .03½	.03 - .03½	.03½- .03½
Prussiate, yel. drums, lb.	.11½- .12	.11½- .12	.11½- .12
Silicate (30°, drums), cwt.	.60 - .70	.60 - .70	.75 - 1.15
Sulphide, fused, 60-62%, dr., lb.	.02½- .03½	.02½- .03	.03½- .04
Sulphite, crys., bbl., lb.	.03 - .03½	.03 - .03½	.02½- .03
Strontium nitrate, bbl., lb.	.03 - .03½	.03 - .03½	.02 - .03½
Sulphur, crude at mine, bulk, ton	18.00 -	18.00 -	18.00 -
Chloride, dr., lb.	.05 - .06	.04 - .05	.04 - .05
Dioxide, cyl., lb.	.06½- .07	.07 - .08	.09 - .10
Flour, bag, cwt.	1.55 - 3.00	1.55 - 3.00	1.55 - 3.00
Tin bichloride, bbl., lb.	.12½-	nom. -	.15 -
Oxide, bbl., lb.	.40 -	.41 -	.53 -
Crystals, bbl., lb.	.31 -	.30½-	.36 -
Zinc chloride, gran., bbl., lb.	.06½- .06½	.06½- .06½	.06½- .06½
Carbonate, bbl., lb.	.10½- .11	.10½- .11	.10 - .11
Cyanide, dr., lb.	.41 - .42	.40 - .41	.40 - .41
Dust, bbl., lb.	.07½- .08	.08 - .08½	.09 - .10
Zinc oxide, lead free, bag, lb.	.06½-	.06½-	.06½-
5% lead sulphate, bags, lb.	.06½-	.06½-	.06½-
Sulphate, bbl., cwt.	3.00 - 3.25	2.75 - 3.00	2.75 - 3.00

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.12 -$0.12½	$0.12 -$0.13	$0.13½-$0.14
Chinawood oil, bbl., lb.	.11½-	.11½-	.14½-
Coconut oil, Ceylon, tanks, N.Y., lb.	.06½-	.06½-	.08 -
Corn oil crude, tanks, (f.o.b. mill), lb.	.07½-	.07½-	.08½-
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.07½-	.07 -	.08½-
Linseed oil, raw, car lots, bbl., lb.	.144-	.138-	.098-
Palm, Lagos, casks, lb.	.07½-	.07½-	.09 -
Niger, casks, lb.	.07 -	.07 -	.08½-
Palm Kernel, bbl., lb.	.07½-	.07½-	.08½-
Peanut oil, crude, tanks (mill), lb.	.07½-	.07½-	.10 -
Rapeseed oil, refined, bbl., gal.	.68 - .70	.68 - .70	.86 - .87
Soya bean, tank (f.o.b. Coast), lb.	.09½-	.09½-	.09½-
Sulphur (olive foots), bbl., lb.	.07½-	.07½-	.10½-
Cod, Newfoundland, bbl., gal.	.55 - .57	.57 - .59	.65 - .67
Menhaden, light pressed, bbl., gal.	.63 - .65	.63 - .65	.70 - .72
Crude, tanks (f.o.b. factory), gal.	nom. -	nom. -	.48 -
Whale, crude, tanks, gal.	.80 -	.80 -	- .80
Grease, yellow, loose, lb.	.05½-	.05½-	.07½-
Oleo stearine, lb.	.09 -	.09½-	.09½-
Red oil, distilled, d.p. bbl., lb.	.10½-	.10 -	.09½- .09½
Tallow, extra, loose, lb.	.06 -	.06½-	.08½-

Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.85 - .90
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.35 - .36
Aniline oil, drums, extra, lb.	.15 - .15½	.15 - .15½	.15 - .16
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .25
Anthracene, 80%, drums, lb.	.60 - .65	.60 - .65	.60 - .65

Coal-Tar Products (Continued)

	Current Price	Last Month	Last Year
Benzaldehyde, U.S.P., dr., lb.	1.15 - 1.25	1.15 - 1.35	1.15 - 1.25
Benzidine base, bbl., lb.	.65 - .67	.65 - .67	.70 - .72
Benzoic acid, U.S.P., kgs, lb.	.57 - .60	.57 - .60	.58 - .60
Benzyl chloride, tech., dr., lb.	.25 - .26	.25 - .26	.25 - .26
Benzol, 90%, tanks, works, gal.	.22 - .24	.22 - .24	.22 - .23
Beta-naphthol, tech., drums, lb.	.22 - .24	.22 - .24	.22 - .24
Cresol, U.S.P., dr., lb	.14 - .17	.14 - .17	.18 - .20
Cresylic acid, 97%, dr., wks., gal.	.60 - .70	.66 - .70	.73 - .75
Diethylaniline, dr., lb.	.55 - .58	.55 - .58	.58 - .60
Dinitrophenol, bbl., lb.	.30 - .32	.30 - .31	.31 - .35
Dinitrotoleun, bbl., lb.	.16 - .17	.17 - .18	.17 - .18
Dip oil, 25% dr., gal.	.26 - .28	.26 - .28	.28 - .30
Diphenylamine, bbl., lb.	.39 - .40	.39 - .40	.45 - .47
H-acid, bbl., lb.	.68 - .70	.68 - .70	.63 - .65
Naphthalene, flake, bbl., lb.	.04½ - .05	.04½ - .05	.05 - .06
Nitrobenzene, dr., lb.	.08½ - .09	.08½ - .09	.08½ - .10
Para-nitraniline, bbl., lb.	.51 - .55	.51 - .55	.52 - .53
Para-nitrotoluine, bbl., lb.	.29 - .30	.29 - .31	.28 - .32
Phenol, U.S.P., drums, lb.	.14½ - .15	.14½ - .15	.15 - .17
Picric acid, bbl., lb.	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., lb.	1.50 - 1.80	1.75 - 1.90	1.35 - 1.50
R-salt, bbl., lb.	.44 - .45	.44 - .45	.47 - .49
Resorcinal, tech., kegs, lb.	1.15 - 1.25	1.15 - 1.25	1.30 - 1.40
Salicylic acid, tech., bbl., lb.	.33 - .35	.33 - .35	.30 - .32
Solvent naphtha, w.w., tanks, gal	.28 - .30	28 -	.35 - .....
Tolidine, bbl., lb.	.91 - .93	.91 - .93	.95 - .96
Toluene, tanks, works, gal.	.35 -	.35 -	.35 - .....
Xylene, com., tanks, gal.	28 - 30	28 - .30	36 - .40

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton	$23.00-$25.00	$23.00-$25.00	$23.00-$25.00
Casein, tech., bbl., lb.	13½ - .15	.14 - .16	.16 - .17
China clay, dom., f.o.b. mine, ton	8 00 -20.00	10.00 -20.00	10.00 -20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.05 - .22	.05 - .22	.06½ - .07
Prussian blue, bbl., lb.	.35 - .36	.35 - .36	.31 - .32
Ultramine blue, bbl., lb.	.06 - .32	.06 - .32	.03 - .35
Chrome green, bbl., lb.	.27 - .28	.27 - .28	.27 - .30
Carmine red, tins, lb.	6 00 - 6 50	6 00 - 6 50	5.25 - 5.50
Para toner, lb	.77 - .80	.77 - .80	.70 - .80
Vermilion, English, bbl., lb.	1 90 - 2 00	1.90 - 2 00	1.80 - 1.85
Chrome yellow, C. P., bbl., lb.	.17 - .17½	.17 - .17½	.15½ - .16
Feldspar, No. 1 (f.o.b. N.C.), ton	6 50 - 7.50	6 50 - 7 50	5.75 - 7.00
Graphite, Ceylon, lump, bbl., lb.	.04 - .05	.04 - 05	.08 - .09
Cum copal Congo, bags, lb.	.07½ - .08	.07½ - .08	.07½ - .08
Manila, bags, lb.	.16 - .17	.16 - .17	.15 - 18
Damar, Batavia, cases, lb.	.18 - .19	.18 - .19	.22 - .23
Kauri No. 1 cases, lb.	.48 - .50	.48 - 53	.48 - 53
Kieselguhr (f.o.b. N. Y.), lb.	50.00 -55.00	50.00 -55 00	50.00 - 55 00
Magnesite, calc, ton	40.00 -	40.00 -	40 00 - .....
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	03 - .40	03 - .40	.03 - .35
Rosin, H., bbl.	8.40 -	8 20 -	8 45 - .....
Turpentine, gal.	.55 - .55½	.54½ -	.53 - .....
Shellac, orange, fine, bags, lb.	.55 - .58	.55 - .58	.61 - .62
Bleached, bonedry, bags, lb.	.38 - .40	.38 - .40	.56 - .60
T. N. bags, lb.	.27 - .28	.27 - .28	.46 - .47
Soapstone (f.o.b. Vt.), bags, ton	10 00 -12.00	10 00 -12.00	10 00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton	9 50 -	9.50 -	10.50 - .....
300 mesh (f.o.b. Ga.), ton	7 50 -10.00	7 50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton	13 75 -	13.75 -	13.75 - ...

	Current Price	Last Month	Last Year
Wax, Bayberry, bbl., lb.	$0 27 $0 29	$0 27 $0.29	$0.31 -$0.32
Beeswax, ref., light, lb.	36½ - .37	36 - 37	.41 - .42
Candelilla, bags, lb.	.19 - .20	.19 - .20	.23 - .24
Carnauba, No. 1, bags, lb.	.31 - .32	31 - .32	.50 - .51
Paraffine, crude 105-110 m.p., lb.	.04 - .04½	04½ - .05	.04½ - .05

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18%, ton	$200 00-	$200.00-	$200.00- ....
Ferromanganese, 78-82%, ton	94 00-99 00	100 00-	105 00- ....
Spiegeleisen, 19-21%, ton	33.00-	33.00-	32.00- .....
Ferrosilicon, 14-17%, ton	45 00	45.00-	45.00- .....
Ferrotungsten, 70-80%, lb.	1.45	1.45-	1.35- ...
Ferro-uranium, 35-50%, lb.	4.50-	4.50-	4.50- ...
Ferrovanadium, 30-40%, lb.	3.15 3.50	3 15- 3 75	3.15- 3.75

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic, lb.	$0 17½-	$0.17½ -	$0.19 - .....
Aluminum, 96-99%, lb.	24 - .30	.24 - .26	.24 - .25
Antimony, Chin. and Jap., lb.	.08 -	08½-	.09½- .....
Nickel, 99%, lb.	35 -	.35 -	.35 - .....
Monel metal, blocks, lb.	28 -	.28 - .28	28 - .....
Tin, 5-ton lots, Straits, lb.	.36½ -	.36½ -	45½ - .....
Lead, New York, spot, lb.	.05½ -	05½ -	.0715 .....
Zinc, New York, spot, lb.	.0495	.053 -	.07 - .....
Silver, commercial, oz.	42½ -	41¾	55¾ - .....
Cadmium, lb.	.80 - .85	80 - .85	85 - .95
Bismuth, ton lots, lb.	1 70 -	1 70 -	1 70 - .....
Cobalt, lb.	2 10 - 2.50	2 10 - 2.50	2 50 - .....
Magnesium, ingots, 99%, lb.	85 - 1.10	85 - 1.10	85 - 1.10
Platinum, ref., oz.	46.00- 48.00	55 00- 56.00	70.00-70.00
Palladium ref., oz.	30 00 35 00	30.00- 35.00	42.00-46.00
Mercury, flask, 75 lb.	113 00 115.00	120.00-	123 00- .....
Tungsten powder, lb.	1.70 1 75	1 35- 1.50	1.10- 1.15

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks., ton	$7 50- $8 00	$7 50- $8.50	$5.50- $8.75
Chrome ore, c.f. post, ton	21 50- 25 00	21 50- 25.00	22 00- 23 00
Coke, fdry., f.o.b. ovens, ton	2 75- 2 85	2 75- 3.85	2 85- 3.00
Fluorspar, gravel, f.o.b. Ill., ton	18 00- 20.00	18.00- 20.00	17 00- 18.00
Manganese ore, 50% Mn., c.i.f. Atlantic Ports, unit	31 - 36	31 - 36	.36 - 38
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y., lb.	48 - .50	48 - 50	.48- .50
Monazite, 6% of ThO_2, ton	60.00-	60 00-	130.00- .....
Pyrites, Span. fines, c.i.f., unit	.13 -	.13 -	.13 - .....
Rutile, 94-96% TiO_2, lb.	.10 - .11	.10 - .11	.11 - .13
Tungsten, scheelite, 60% WO_3 and over, unit	15 25- 16.50	15 25 - 16.50	11 25 -11.50
Zircon, 99%, lb.	.03 -	.03 -	.03 - ....

CURRENT INDUSTRIAL DEVELOPMENTS

New Construction and Machinery Requirements

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Alloy Factory—P. B. West, 24 Commerce St., Newark, N. J., will soon award contract for a 2 story factory, etc. on Maple Pl. for General Alloy Co., 188 New Jersey Railroad Ave., Newark. Estimated cost $40,000.

Plant—Bakelite Corp., 230 Grove St., Bloomfield, N. J., has work under way on the construction of a 3 story building to house research and development in Bakelite air-drying varnishes, laminated structural materials and halowax. Estimated cost $100,000. J. W. Ferguson Co., 152 Market St., Paterson, is contractor.

Bronze Factory—W. S. Tyler Co., West 36th St. and Superior Ave., Cleveland, O., is having plans prepared for the construction of a factory for the manufacture of ornamental iron and bronze at St. Catherines, Ont. Estimated cost $150,000. G. S. Rider Co., Marshall Bldg., Cleveland, is architect.

Wire and Cable Drawing Plant — American Brass Co., Grand and Meadow Sts., Waterbury, Conn., is having plans prepared for addition to wire and cable drawing plant at Hastings-on-Hudson, N. Y. Estimated cost $450,000. Private plans.

Cement Plant—Florida Portland Cement Co., Hookers Point, Tampa, Fla., plans increasing loading and docking facilities, etc. Estimated cost $80,000.

Cement Storage Bins — Canada Cement Co., H. O. Canada Cement Bldg., Montreal, Que., awarded contract for the construction of two cement storage bins, 60 ft. high at Windsor, Ont., to MacDonald Engineering Co. Ltd. Canadian Pacific Railroad Bldg., Toronto. Estimated cost $60,000.

Steel Bins — Idaho Portland Cement Co., Boise, Idaho, will soon receive bids for new steel bins at Inkom plant. Estimated cost $60,000.

Chemical Plant—W. H. Monsarratt Inc., W. H. Monsarratt, Pres., Exchange Bldg., Memphis, Tenn., plans the construction of a plant for the manufacture of chemicals. Estimated cost $35,000.

Chemical Factory—Rose International Chemical Co., 330 East Channel St., Stockton, Calif., plans the construction of a chemical factory. Estimated cost $100,000. Architect not selected.

Chemical Plant—Merrimac Chemical Co., 148 State St., Boston, Mass., plans the reconstruction of chemical plant recently destroyed by fire will include number of units, probably under separate bids. Estimated cost $1,000,000. Bids will soon be called for a 3 story, 85 x 110 ft. sulphur acid building.

Chemical Plant — Plough Chemical Co., 121 South Second St., Memphis, Tenn., will soon receive new bids for the construction of a chemical plant. Estimated cost $450,000. Hanker & Cairns, 123 South Court St., Memphis, are architects. Former bids rejected.

Clay Products Plant — National Fireproofing Co., Fulton Bldg., Pittsburgh, Pa., plans the construction of a 1 story, 100 x 150 ft. factory for the manufacture of clay products and building tile, etc., at Waynesboro, O. Estimated cost $50,000 to $75,000. Private plans.

Coke Ovens and Gas Producer Building—New England Fuel & Transportation Co., 250 Stuart St., Boston, Mass., awarded contract for the construction of sixty-seven coke ovens, also 60 x 175 ft. gas producer building on Rover St., Everett, to The Koppers Co., Koppers Bldg., Pittsburgh, Pa.

Coke Plant — Seaboard By-Products Coke Co., Newark Turnpike and Hackensack River, Kearny, N. J., awarded contract for a 3 story plant to Rust Engineering & Construction Co., 30 Church St., New York. Estimated cost $150,000.

Compress Plant Addition—Aransas Compress Cotton Co., Corpus Christi, Tex., will soon award contract for a 1 story addition to compress plant and storage unit, 30,000 bales capacity. Estimated cost $125,000. Hardy & Curran, Nixon Bldg., Corpus Christi, are architects and engineers.

Absorbant Cotton & Gauze Mill — Certified Laboratories Inc., c/o G. H. Carter, Pres., Marlin and Marble Falls, Tex., plans the construction of a plant for the manufacture of absorbant cotton and gauze at Marble Falls. Estimated total cost $250,000. Private plans. Most of equipment purchased.

Cotton Oil Plant — Conway Cotton Oil Co., H. B. Zachary, Mgr., Conway, Ark., plans to rebuild cotton oil mill destroyed by fire. Estimated cost $75,000.

Cotton Oil Mill—Sunflower Cotton Oil Co., H. M. Trice, Mgr., Indianola, Miss., plans to rebuild cotton oil mill recently destroyed by fire. Private plans.

Creosoting Plant — Calders Ltd., 388 St. James St., Montreal, Que., plans the construction of a 1 story creosoting plant at Brampton, Ont. Estimated cost $50,000. J. Kulis, c/o W. P. Hinton, 1407 Royal Bank Bldg., Toronto, is engineer. Machinery and equipment including a 100 ft. retort will be required.

Creosote Plant — International Creosoting & Construction Co., Pine and Long Sts., Beaumont, Tex., plans the construction of a storage plant, also two or more tanks, 17,500 bbl. capacity each, for storing creosote. Private plans.

Distillery — Federal Distilleries Ltd., 6659 Park St., Montreal, Que., plans the construction of a distillery. Estimated cost $150,000.

Enameling Plant—Montague Stove & Furnace Works, R. T. Montague, Pres., 101 West Columbia Blvd., Portland, Ore., plans the construction of a 2 story, 60 x 150 ft. enameling plant. Estimated cost $150,000. Architect and engineer not selected. Machinery and equipment will be required.

Humite Plant—Plant Land & Food Co., W. Scott, Gen. Mgr., Dundee, Fla., plans addition to plant for the manufacture of "Humite." A. W. Koon, c/o National Blow Pipe & Mfg. Co., 738 Dryades St., New Orleans, La., is engineer.

Fur Dyeing Plant — Rosenblum & Jasper, Meeker Ave. and Varick St., Brooklyn, N. Y., awarded contract for the construction of a fur dyeing plant to R. N. R. Construction Co., 56 West 45th St., New York, N. Y. Estimated cost to exceed $40,000.

Gas Compressor Plant—Colorado Interstate Gas Co., subsidiary of Cities Service Co., 60 Wall St., New York, N. Y., will soon award contract for a gas compressor plant at Clayton, N. M. Estimated cost to exceed $500,000. Ford, Bacon & Davis, 39 Broadway, New York, N. Y., are engineers.

Gas Plant Extensions — Connecticut Power Co., 33 Union St., New London, Conn., awarded contract for extensions to gas manufacturing plant on Water St. to United Engineers & Constructors, 112 North Broad St., Philadelphia, Pa. Estimated cost to exceed $40,000.

Carton Glass Factory — Capstan Glass Co., Connellsville, Pa., awarded contract for the construction of a 1 story, 150 x 340 ft. carton glass factory to The Austin Co., Union Trust Bldg., Pittsburgh.

Glass Plant—McDonald Bros. Glass Co., 8773 South San Pedro St., Los Angeles, Calif., J. W. McDonald, 4134 Beach Dr., Seattle, Wash., Secy., plans the construction of first unit of pressed glass plant at Salt Lake City, Utah. Estimated cost $50,000.

Glass Plant — Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa., awarded contract for the construction of a 1 story, 150 x 160 ft. warehouse at Grundy St. and 11th Ave., Nashville, Tenn. to Bell Bros. Co., Murfreesboro, Tenn., also soon takes bids for a 1 story, 110 x 180 ft. warehouse at Mineola, L. I.; 1 story, 70 x 130 ft. factory at Hartford, Conn.; proceeding with extensions and improvements to sheet glass plant at Norwood, W. Va. $200,000.

Glass Sand Refinery—Spicky Polish Co., 1401 3rd St., San Francisco, Calif., plans the construction of a glass sand refinery at Placerville. Estimated cost $75,000.

Kilns — E. Field, 150 Dawes Rd., Toronto, Ont., will build four brick kilns, each 100 ft. in diameter at East York Township. Estimated cost $35,000. Work will be done by day labor.

Kiln Building—Homer Laughlin China Co., Newell, W. Va., awarded contract for the construction of a 1 story kiln building to Harrop Ceramic Service Co., 310 West Broad St., Columbus, O. Estimated cost $60,000.

Chemistry Building—University of California, Los Angeles, Calif., is having plans prepared for the construction of a chemistry building at Riverside. Estimated cost $150,000. G. S. Wilson, 3646 West 9th St., Riverside, is architect.

Laboratory—University of Cincinnati, Clifton Ave., Cincinnati, O., awarded contract for a 3 story, 52 x 93 ft. laboratory to Penker Construction Co., 1030 Sumner St., Cincinnati, O. Estimated cost $150,000.

Laboratory—New Britain General Hospital, T. E. Reeks, 92 Grand St., New Britain, Conn., plans the construction of a hospital including laboratory, etc. Estimated cost to exceed $150,000. Architect not selected.

Laboratory—Oberlin College, Oberlin, O., is having sketches made for the construction of a group of college buildings including laboratory, etc. Estimated cost to exceed $1,000,000. C. Gilbert, 244 Madison Ave., New York, N. Y., is architect. Maturity late in summer.

Laboratory—University of Illinois, Champaign, Ill., is having plans prepared for the construction of a 5 and 7 story laboratory building at Polk, Lincoln and Wood Sts. Estimated cost $1,500,000. Granger & Bollenbacher, 333 North Michigan Ave., Chicago, are architects.

Laboratory—University of Maine, Orono, Me., awarded contract for a 3 story, 50 x 125 ft. laboratory to Cummings Construction Co., 14 Prospect St., Ware, Mass. Estimated cost $150,000.

Laboratories—Woods Hole Oceanographic Institute, F. Lillie, Pres., Woods Hole, Mass., is having preliminary plans prepared for the construction of a laboratory on Water St. Estimated cost $150,000. Coolidge, Shepley, Bulfinch & Abbott, 1 Court St., Boston, are architects.

Laboratory — University of Richmond, F. W. Boatwright, Pres., Richmond, Va., plans the construction of a group of buildings including laboratories, etc. Estimated cost $600,000.

Laboratory (Research) — Copperweld Steel Co., Glassport, Pa., is completing construction of a new research laboratory. Estimated cost $50,000.

Laboratory — Barber Asphalt Co., Maurer, N. J., is having preliminary plans prepared for a 2 story, 50 x 120 ft. laboratory. Estimated cost $100,000. Day & Zimmermann, 112 Broad St., Philadelphia, Pa., are architects and engineers.

Travialithic Factory—Barrett Co. Ltd., Villiers St., Toronto, Ont., awarded contract for structural steel for a plant for the manufacture of "Travialithic" at Dundas to Canadian Bridge Co., Walker Rd., Walkerville. Estimated cost $150,000.

Liquid Carbonic Plant — Liquid Carbonic Corp., Lloyd Bldg., Seattle, Wash., awarded contract for the construction of a 2 story, 150 x 180 ft. factory to The Austin Co., Dexter Horton Bldg., Seattle. Estimated cost $75,000.

Lacquer and Varnish Factory—Arco Co., Los Angeles, Calif., awarded contract for the construction of a 2 story plant for the manufacture of lacquer and varnish on 59th St. to The Austin Co. of California, 777 East Washington St., Los Angeles. Estimated cost $75,000.

Paint Factory—De Soto East Railroad Ave., Memphis, Tenn., awarded contract for a 1 story addition to paint factory including boiler room, shipping room, tank room, warehouse, etc. at Railroad Ave. and East St. to B-W. Construction Co., 720 Cass Ave., Chicago, Ill. Estimated cost $25,000.

Paint Factory—C. W. McCall, 1404 Franklin St., Oakland, Calif., Archt., is receiving bids for the construction of a 3 story factory at 14th Ave. and East 14th St. for Caldów Paint Co., 1422 14th St., Oakland. Estimated cost to exceed $40,000.

Paper Factory—Hinde & Dauch Paper Co., North Haven and Fairmount Ave., Baltimore, Md., plans the construction of a 2 story factory at Biddle St. and Loney's Lane. Architect and engineer not selected.

Paper Plant—Bogalusa Paper Co., R. H. Laftman, Gen. Mgr., Bogalusa, La., awarded contract for addition to plant for the manufacture of Kraft paper to Dye & Mullins, Columbia, La. Estimated cost including equipment $1,000,000.

Paper Mill Extensions — International Paper Co., 100 East 42nd St., New York, N. Y., plans extensions and improvements to hydro-electric plant and paper mill at Delhause, Que. Estimated cost $1,500,000. Also plans a pulp mill at Chatham, N. B. $1,000,000.

Paper Plant Addition—Kimberly Clark Paper Co., Niagara Falls, N. Y., plans addition to paper plant. Estimated cost to exceed $100,000. Private plans.

Paper Plant—Pacific Mills Ltd., 510 Hastings St. W., Vancouver, B. C., awarded contract for a 2 story, 135 x 250 ft. factory for specialty paper manufacture on Raymond Ave. to E. H. Shockley, 230 Central Ave., Vancouver. Estimated cost $150,000.

Stationery Manufacturing Plant—F. N. Burt & Co., 330 Bay St., Toronto, Ont., awarded contract for the construction of a 1 story stationery manufacturing plant at Mount Dennis to Dickie Construction Co., 17 Yorkville Ave., Toronto. Estimated cost $150,000.

Potash and Borax Plant Extensions—American Potash & Chemical Corp., 233 Broadway, New York, awarded contract for design and construction of large additions to manufacturing facilities consisting of extensions to potash and borax plants, new power plant, etc., at Trona, Calif., to United Engineers & Constructors, Inc., 125 East 46th St., New York, N. Y. Estimated cost approximately $4,500,000.

Plant — Hall China Co., East Liverpool, O., is having plans prepared for the construction of a 1 story factory. Estimated cost $40,000. B. H. Prack, Martin Bldg. N. S., Pittsburgh, Pa., is architect.

Prest-O-Lite Plant—Prest-O-Lite Co. Inc., 30 East 42nd St., New York, N. Y., awarded contract for the construction of a 1 story plant and storage building at Cassiano St., San Antonio, Tex., to Sumner Sollitt Co., National Bank of Commerce, San Antonio. $40,877. Also plans a 50 x 100 ft. factory at Fisk and Dalton Sts., Spokane, Wash., $40,000, and an acetylene producing plant at Casper, Wyo. $40,000.

Oil Products Plant — National Oil Products Co., Essex St., Harrison, N. J., will soon award contract for a 4 story, 60 x 85 ft. plant and warehouse. Estimated cost $50,000. Bishop & Scudder, 9 Clinton St., Newark, are architects.

Refinery (Oil) — Southern Cotton Oil Co., K. C. Junction, Memphis, Tenn., plans the construction of a 4 story oil refinery at Binghamton plant. Estimated cost $74,000.

Refinery Stills—Empire Refineries, subsidiary of Cities Service Co., 60 Wall St., New York, N. Y., awarded contract for twelve pressure stills for various refineries to A. O. Smith, 27th and Keefe Sts., Milwaukee, Wis.

Storage Building—U. S. Refining Co., 801 North Main St., Los Angeles, Calif., plans the construction of a bulk storage building on Oak St., Alameda. Estimated cost $80,000. Private plans.

Wax Press Building—Standard Oil Co. of Ohio, E. B. Wagoner, Const. Mgr., East Ohio Gas Bldg., Cleveland, O., awarded contract for the construction of a 1 story wax press building on East 65th St. to The Austin Co., 16112 Euclid Ave., Cleveland. Estimated cost $40,000.

Bulk Plant—Firestone Tire & Rubber Co., 523 Massachusetts Ave., Cambridge, Mass., is receiving bids for the construction of a 2 story bulk plant. Estimated cost $40,000. Private plans.

Rubber Factory — U. S. Rubber Co., 211 Passaic St., Passaic, N. J., awarded contract for the construction of a 6 story, 100 x 175 ft. factory Bldg. No. 25 on Market St., to John W. Ferguson Co., 152 Market St., Paterson. Estimated cost $400,000.

Salt Plant—General Salt Co., 530 West 6th St., Los Angeles, Calif., plans the construction of a plant for the manufacture of iodine at Huntington Beach. Estimated cost $75,000.

Salt Plant—Worcester Salt Co., 71 Murray St., New York, N. Y., awarded contract for the construction of a 1 story, 130 x 215 ft. salt plant, etc. at Silver Springs to John W. Ferguson Co., 152 Market St., Paterson, N. J. Estimated cost $150,000.

Silver Plant—International Silver Co., J. A. Hutchinson, 48 State St., Meriden, Conn., is having preliminary plans prepared for a 1 story, 50 x 300 ft. addition to building No. 1 and 2, Factory E. Estimated cost $50,000. Private plans.

Soap Factory—Lever Bros. Co., 164 Broadway, Cambridge, Mass., awarded contract for a 1 story addition to soap factory to J. Leroy Fox Inc., 101 Milk St., Boston. Estimated cost $40,000.

Smelting Plant—Ozark Smelting & Mining Co., Coffeyville, Kan., awarded contract for addition to plant to North American Car Corp., Coffeyville. Estimated cost $300,000.

Steel Tanks — National Pole Treating Co., Everett, Wash., awarded contract for fabrication and erection of large steel tanks and steel smokestack to Hydraulic Supply Mfg. Co., 7500 8th Ave. S., Seattle.

Sugar Plant Addition — Holly Sugar Co., Tracy, Calif., plans additions to sugar plant including one main building and one pump drier building. Estimated cost $500,000.

Duntile Plant—Duntile Products Co., Elkhart, Ind., will build a factory and boiler house on Baldwin Ave. Estimated cost $41,400. H. Miller, Elkhart, is architect. Work will be done by owners forces.

Marble Furnishing Plant — Rogers Tile Co., 117 Yale St. N., Seattle, Wash., plans the installation of a marble furnishing plant in present plant. Marble manufacturing machinery and equipment to cost $25,000 will be required.

Witch Hazel Plant—E. E. Dickinson & Co., North Main St., Essex, Conn., awarded contract for a 2 story, 25 x 100 and 40 x 50 ft. addition to witch hazel plant to Loucks & Clarke, 6 Ernest St., Wallingford. Estimated cost $65,000.

Zonite Plant—Zonite Products Corp., 250 Park Ave., New York, N. Y., awarded contract for a 4 story, 100 x 200 ft. addition to factory at New Brunswick, N. J. to Shapiro Bros., 1560 Broadway, New York, N. Y. Estimated cost $40,000.